POWER

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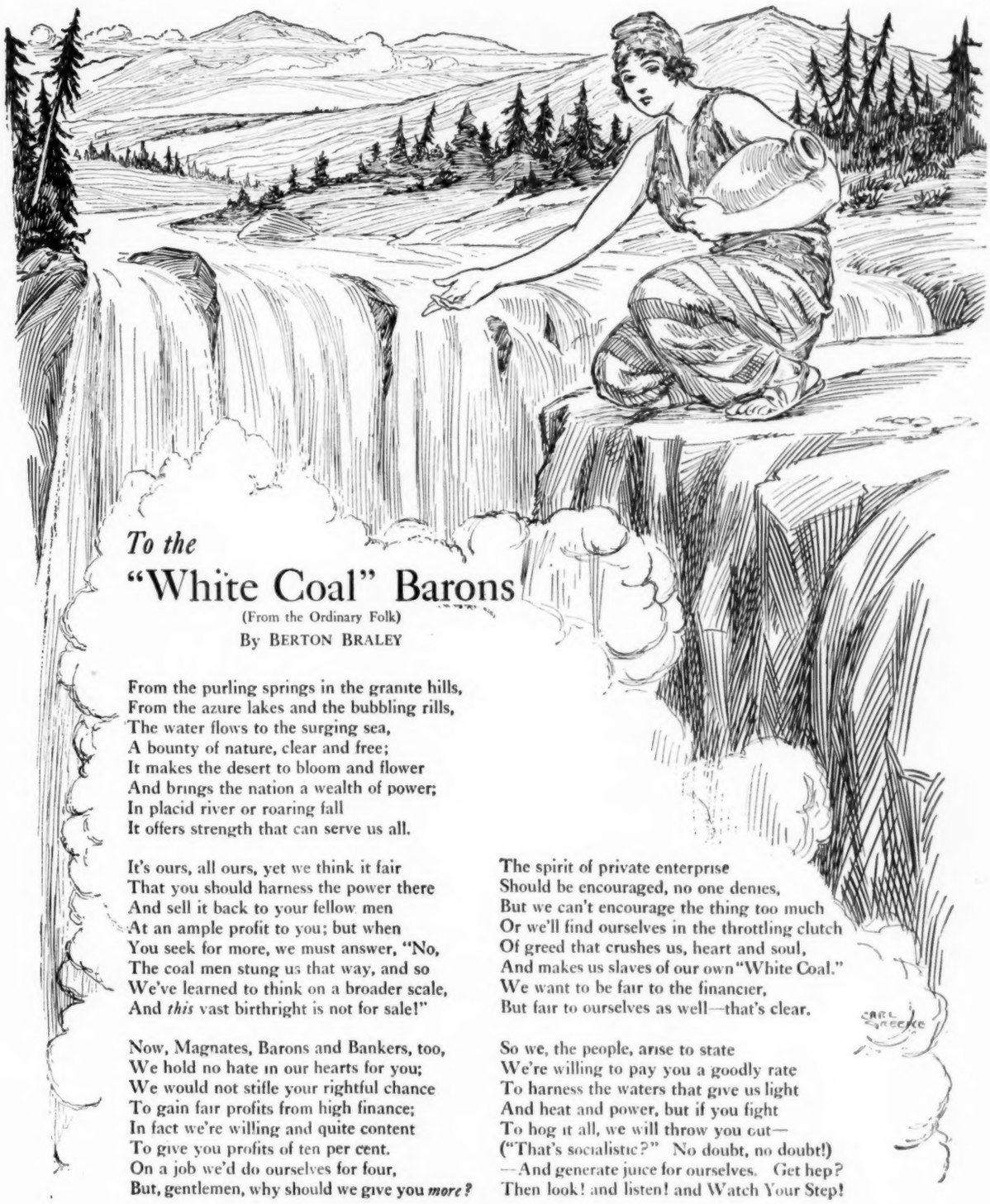


To the "White Coal" Barons

(From the Ordinary Folk)

By BERTON BRALEY

From the purling springs in the granite hills,
From the azure lakes and the bubbling rills,
The water flows to the surging sea,
A bounty of nature, clear and free;
It makes the desert to bloom and flower
And brings the nation a wealth of power;
In placid river or roaring fall
It offers strength that can serve us all.

It's ours, all ours, yet we think it fair
That you should harness the power there
And sell it back to your fellow men
At an ample profit to you; but when
You seek for more, we must answer, "No,
The coal men stung us that way, and so
We've learned to think on a broader scale,
And *this* vast birthright is not for sale!"

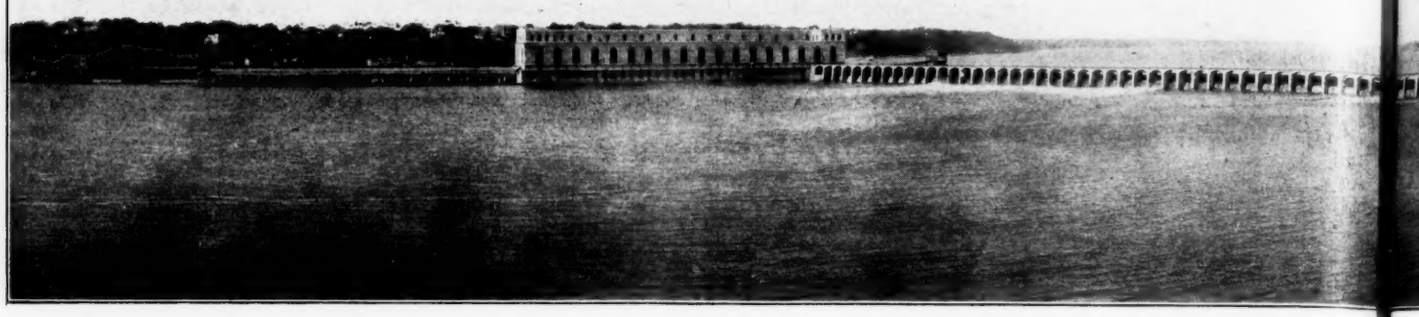
Now, Magnates, Barons and Bankers, too,
We hold no hate in our hearts for you;
We would not stifle your rightful chance
To gain fair profits from high finance;
In fact we're willing and quite content
To give you profits of ten per cent.
On a job we'd do ourselves for four,
But, gentlemen, why should we give you *more?*

The spirit of private enterprise
Should be encouraged, no one denies,
But we can't encourage the thing too much
Or we'll find ourselves in the throttling clutch
Of greed that crushes us, heart and soul,
And makes us slaves of our own "White Coal."
We want to be fair to the financier,
But fair to ourselves as well—that's clear.

So we, the people, arise to state
We're willing to pay you a goodly rate
To harness the waters that give us light
And heat and power, but if you fight
To hog it all, we will throw you out—
("That's socialistic?" No doubt, no doubt!)
—And generate juice for ourselves. Get hep?
Then look! and listen! and Watch Your Step!

Water Power Development

By Hon. Franklin K. Lane, Secretary of the Interior



SYNOPSIS—Prepared especially for Power and expressing the Government's attitude in the water power controversy which has waged in and out of Congress for the past few years.

Should the Government allow its dam and reservoir sites and other lands valuable for power development to pass from its hands forever?

1. It has been the policy of Congress from the inception of power development in the United States only to grant permission to use such lands and not to sell or give away the lands in perpetuity. See Acts of Congress of May 18, 1896 (29 Stat., 120); Feb. 15, 1901 (31 Stat., 790); Feb. 7, 1905 (33 Stat., 702); May 1, 1906 (34 Stat., 163); and Mar. 4, 1911 (36 Stat., 1253).

2. The general law applicable to the use of public lands for the development of electrical power, the act of Feb. 15, 1901, authorizes the grant only of a permission to use public lands and reservations for this purpose, expressly providing that any such permission may be revoked by the Secretary of the Interior or his successor, in his discretion, and shall not be held to confer any right or easement, or interest in, to or over any public land or reservation. The general law now in effect relative to granting of rights of way for transmission lines, the act of March 4, 1911, only grants the approval of such rights of way for periods not exceeding fifty years.

3. The future of water power is still unknown. It promises to be an invaluable resource, (a) because it replaces itself, while coal and oil do not; (b) because it can be transported at slight expense and for long distances; (c) because the development of numerous other Western resources, low-grade ores, irrigation of arid lands by pumping and the establishment of manufacturing enterprises are dependent upon cheap and abundant electrical power.

4. To grant at this time such lands in perpetuity to private corporations or individuals is to divest the Federal Government, as well as the several states, of a large measure of the control which it might otherwise exercise over this resource by law or regulation and would place beyond its power the opportunity of providing by law such different method of use or disposition as the future may show to be best adapted to the public interests.

With possibly few exceptions, the valuable power sites on lands not owned by the Federal Government have passed into private ownership in perpetuity. They cannot be recovered, except at a prohibitive expense, nor can control be exercised thereover in any manner, except it be by regulation of transmission and delivery as a public utility. Of all the horsepower developed in the United States, Government statistics show that a comparatively small number of companies control 90 per cent. According to a table compiled by the Forest Service, out of a total of 1,135,400 hp. developed in the States of California, Colorado, Idaho, Montana, Nevada, Oregon, Utah and Washington, 1,023,700 hp. is owned by large corporations, while but 111,700 hp. is owned by small developers. In the State of California 92 per cent. of the developed power is owned by the large corporations and but 8 per cent. by small developers. In Oregon 90 per cent. is owned by large companies, and in California one corporation owns 27 per cent. of the total developed horsepower in the state and two groups own 57 per cent. of the total development. This shows what the states have done with the power sites. Now let us consider what the Federal Government has done with its sites.

Undeveloped Resources Large

As stated, it has never been the policy of Congress to dispose of these sites in perpetuity, the laws providing simply for the issuance of limited or revocable permits. Therefore, while some valuable sites have been acquired by private owners through the filing of scrip or entry of the lands under some one of the land laws not intended to apply to the development of such a resource, the major portion of lands valuable for this development remains in Federal ownership. A conservative estimate places the total available horsepower at 35,000,000, of which not exceeding 8,000,000 has been developed. Of the total undeveloped horsepower, about 74 per cent. (28,000,000) is in what is known as the public-land states and 42 per cent. of the total is within Government forest reserves. It is thus apparent that the extent and value of this undeveloped resource is large enough to require most careful consideration and disposition.

Let us therefore consider first how other governments deal with the problem of power sites.

The laws of the Dominion of Canada authorize the issuance of licenses for 21 years, renewable for three further terms of like extent, at a fixed fee, payable annually, and provide that upon the termination of a license the works may be taken over by the government upon payment of

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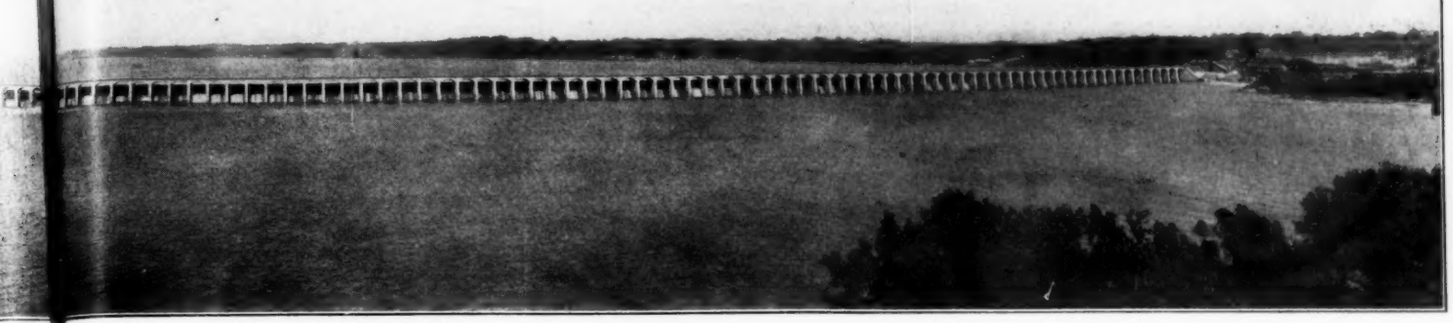
Follies of the Ferris Bill

By Hon. Reed Smoot, U. S. Senator from Utah



SYNOPSIS—Senator Smoot voices the opinion of the water power interests of the West and proposes state control in place of Federal control as a solution to the water power problem.

The report of the majority of the Senate Committee on Public Lands states that the object of the Water Power Development Bill is: "The better and speedier development for useful and beneficial purposes of the great undeveloped water power of the country, now lagging on account of inadequate and inefficient laws."

If this were the real object and purpose of this bill and this object could be attained even in reasonable degree, and without unwarranted and dangerous encroachments by the National Government on the constitutional rights of the states, I should not be found contending against its enactment, because I represent a constituency that is vitally interested in the development of all natural resources and their application to beneficial uses, freed as far as possible from limitations, obstructions or unnecessary burdens of any kind. In any attempt to bring about such legislation we should carefully consider:

1. The rights of the states in the waters flowing through them in the natural streams and to regulate and control their appropriation, diversion and use.

2. The limitations of the National Government in dealing with the appropriation, regulation and use of these waters.

3. The rights of the people of the states to the use of the waters of the streams, as provided by law, commonly called the consumers.

But, after all and in the last analysis, it is the consumer that should be protected and his individual right to the use of the water maintained and preserved under reasonable rules and regulations that will insure the greater and more beneficial use of the water for all legitimate purposes.

The Western semi-arid states, where irrigation is necessary to their full development and prosperity, are peculiarly and vitally interested in making every drop of water beneficially useful and in supplying every acre of land possible with the water, without which much of their lands are sterile and unproductive. This being true, it must be seen that these states are interested and will support any just law that will extend the use of water either for the irrigation of their land or for the development of power. If I believed that this bill would have that effect without violating any of the fundamental and constitutional rights of the states, it would receive my earnest support. It is because I am fully convinced of my own knowledge of the subject and the testimony taken at the hearings before the committee that the bill will not conduce to the better or speedier development of the water power of the country, but will hinder and retard such development, and that its real object, purpose and effect is to usurp by the National Government the rights and jurisdiction of the states in and over the flowing waters of the streams to the detriment of the states and to water consumers, that I earnestly oppose its passage.

Before taking up the various provisions of the bill in detail, it might be wise to consider it briefly as a whole.

The bill in its entire scope and purpose is an infringement upon and a usurpation of the sovereign powers of the states. This is not only its effect, but it is the avowed intention of its friends to transfer, in part, at least, from the states to the National Government the control over the use of the waters of the streams within the states.

Objections to Leased Lands

Ostensibly it is proposed to authorize the Government to lease its own lands. To this there are serious objections, which I shall point out later. But the public lands which may be leased for power sites are of themselves practically worthless. The Government has no ownership or interest in the water flowing in the stream except that of a riparian owner and that only in states where riparian rights are recognized. In most of the Western States riparian rights are abolished and the ownership of the water vested in the whole people of the state, to be appropriated and applied to beneficial uses as the laws of the state may provide. The Government owns this land precisely as a private individual owns his land and with the same rights and privileges as to the use of the water that flows by it—no more, no less. It does not own it in its sovereign capacity and has no sovereign power over it or over the water that flows past it. But the effect of the bill is to lease, not alone the land it owns, but the waters of the streams upon which it borders and, by conditions and restrictions in the lease, to determine how and for what purposes the lessee shall use the water as well as the land. This is in violation of the principles enunciated by many United States courts and is an encroachment upon, and a plain and open violation of, the sovereign rights of the states to govern and control such use.

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Water Power Development

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the value of the actual and tangible works and of any lands held in fee in connection therewith. It is expressly provided that the value of the rights and privileges granted or the revenues, profits or dividends being, or likely to be, derived therefrom shall not be taken into consideration.

The province of Ontario authorizes a lease of water-power privileges for periods not exceeding twenty years, with the right of renewal for two further and successive terms of ten years each, upon the rental stated in the lease and such conditions as the Minister may prescribe. Upon the termination of the lease, the privileges, together with all dams or other structures or works made or erected by the lessee in connection therewith, revert to and become the property of the Crown, subject, however, to the right of the lessee to such sums as the Minister may deem proper for buildings or structures of a permanent character and necessary or useful to the development or utilization of the water privilege.

Governor Authorized To Make Regulations

In the provinces of Manitoba, Saskatchewan, Alberta, Yukon and Northwest Territory, the governor in council is authorized to make regulations for the diversion, taking or use of water for power purposes and for the construction of power-development works on public lands. He is also authorized to fix the fees, charges, rents, royalties or dues to be paid and the rates to be charged.

In Queensland the law authorizes water-power development under special license, subject to such conditions and provisions as the governor in council shall determine, for periods of ten years.

In France power plants on national lands are developed under concessions for periods not exceeding fifty years, at the expiration of which period the grantee, if concession be not renewed, is required to restore the premises to the conditions previously existing or to deliver the plant to the nation without indemnity, as the nation may elect. The amount of rental to be paid is required to be fixed in the articles of concession.

In Norway the law authorizes the granting of concessions for power development for a minimum of sixty years and a maximum of eighty years. When the concession expires, the land, with improvements and works, reverts to the government. Various payments for the privileges are required, among them being the establishment of a poor fund under public control, the surrender of a certain percentage of produced power to the community and to the general government and, in certain specified developments, there may be assessed a yearly tax of 1.25 crowns for every horsepower over five hundred.

Federal Control Essential

Water-power transmission does not stop at state lines. Power development and long-distance transmission connect widely separated localities and communities. The public interest requires that there be no hiatus. Where state control ceases or does not exist, Federal control is essential to protect the people.

It is generally conceded that the water-power resources upon the public domain cannot be developed under existing laws, because of the uncertain tenure involved by revocable permits. This is true: First, because the engineer and the promoter fear to embark on an enterprise under such conditions; second, because the capitalist will not loan money upon such security; third, because the consumers can have no positive assurance that they will be supplied for a fixed and definite period.

It is an established fact that numerous responsible persons who have obtained permits to develop water-power sites under the existing law have been unable to construct because of the foregoing.

What, then, should the new law be?

The ideal law is one which will give to the developer and investor an assured tenure for a period long enough to justify his investment and reward his efforts. It must be under conditions known to him in advance, so that his plans may be laid accordingly. It must encourage development without losing sight of the needs of the consumer and the rights of the people.

The gift of a franchise means, generally, the gift of additional profit to the promoter. Its benefit is not passed on to the consumer. There is nothing connected with such a gift that obligates or induces the developer to make low rates to the consumer or which obligates him to deal more favorably with the general public. Municipalities have generally abandoned the practice of giving away franchises. The people expect and demand that valuable rights shall yield something in the way of direct return.

A nominal sale charge is equally objectionable. It has the appearance of yielding a return, while in fact it is more trouble than it is worth, and therefore imposes a burden upon the developer, while yielding nothing or substantially nothing, to the people. Such a nominal charge is also worthless as a regulative measure.

Reservoir Sites not Agricultural

When we examine the value of public lands suitable for reservoir sites, we find that they are practically valueless from an agricultural standpoint, because, generally speaking, such lands are in canyons or in mountainous regions, valueless for agriculture, of little value for grazing and of little worth for other purposes than the development of electric power. Of this value 5 per cent. would be negligible and not worth collecting. The amount of $1.25 per acre has been suggested as the agricultural value of public lands, because homesteaders may commute at that figure. But this does not represent a sale of lands. It is an arbitrary price exacted by law as an evidence of good faith in connection with the submission of final proof on a homestead prior to the expiration of the ordinary homestead period.

The present real value of a tract of land for agricultural purposes could be determined only through a scheme of advertising and competitive open bidding. But the Government does not dispose of other lands or values upon this theory at all. Timber land is disposed of at a price fixed after careful consideration and appraisement, the sale price being based on the timber value. Coal land is disposed of on an appraisement based on the amount of coal content and a royalty of approximately two cents per ton.

The true value of power sites is, then, not the nominal figure of $1.25 per acre, not their value as agricultural lands, timber lands or coal lands, but their value as dam sites, reservoir sites or for other uses in connection with water-power development; and for this purpose the larger and more valuable sites are worth millions of dollars.

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Follies of the Ferris Bill

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In the first section the bill authorizes the Secretary of the Interior to lease lands of the Government for the "development, generation, transmission and utilization of hydro-electric power."

Nearly all states where irrigation is practiced and in which this law would operate, have, either by direct statutory provisions or rules and regulations adopted by utility commissioners or other authorized official bodies, provided what uses of water shall be preferred over others where the water supply from any source is insufficient to meet all needs, usually in the following order: Domestic use, irrigation, development of power. This whole bill proceeds upon the theory that the Government can fix and designate the use to which the water shall be devoted, in spite of contrary rules fixed by the states. But I apprehend that, if such a lease as is proposed were made and the power plant erected, the state could at any time require that the water used for the purpose of generating power be applied to domestic use or irrigation, if the water is needed for that purpose, and the lessee's lease and plant rendered valueless. If not, then the Government has, by its lease and the application of the water to a single and specific use, deprived the state of its undoubted sovereign right to determine the uses to which the water shall be applied. No one can doubt that in a conflict of this kind between the two governments the right of the state to say how and for what purposes water shall be used would be sustained.

The vice of this first section runs through the whole bill. All of its provisions and limitations relate wholly to the use of water for the generation of power.

Let us now consider the limitation of the lease to a period of fifty years.

Fifty-Year Tenure at Variance with States' Rights

Any attempt to limit the life of a plant for the distribution and use of water is entirely at variance with the whole theory of water rights in the Western States. Where water is put to use for irrigation, for example, the use must be perpetual and not for a limited term, otherwise the landowner might have the use of the water until his trees are matured and then lose his supply, bringing destruction upon his trees and his crops. To prevent this, it is provided by statute in most if not all the irrigation states, that if a public-service corporation shall once supply water to land for irrigation the right to its continued and perpetual use, as an appurtenant to his land, attaches and passes, like other appurtenances, by a conveyance of the land. The selection of an arbitrary period of fifty years, therefore, violates the laws of a number of states where this bill would be vitally important.

By another provision of the bill the Government is authorized to take over not only the land which it has leased, but a water-power plant to be used and which must continue to be used for the generation of power for public use and to become a public-utility corporation, obligated to operate the plant and supply power to the public. When it assumes this function, it becomes at once bound by the contracts and other obligations of the lessee to supply the power. It at once becomes amenable to the state authorities having power to regulate its business. If not, then the effect is to deprive the state of the right to regulate the use of the waters of the state as an exercise of its sovereign power. It may well be asked how, when the National Government becomes a utility corporation, the state can exercise against it the power it has to regulate rates or otherwise control the use and operation of the plant, even to the extent, as it may, of taking away the use of the water and requiring it to be used for other purposes more necessary for the public good than the development of power.

Neither the state nor any consumer under the system could sue the Government or compel it in any way to perform its duty as a public-service corporation. This provision, if not illegal, is, it seems to me, absurd. It would lead to untold and innumerable conflicts of governmental authority and complications.

Government Ownership of Public Lands Established

The principle that the Government owns the public lands as a proprietor and not in its sovereign capacity is too clearly and firmly established to admit of doubt. In a sense the Government owns the land in trust, to dispose of it for use by the citizens of the country. Laws have been enacted from time to time providing for their disposition. Until now the national policy has been to convey the absolute title to the land in whatever way it may be disposed of. But it is now proposed to hold the title of the land in the Federal Government and lease it on long leases. This would be a radical change in governmental policy and one which would be extremely important to the states, for the land in the hands of the Government is not subject to taxation by the states.

In the hearings by the committee this startling statement was made by Senator Shafroth, of Colorado:

> I believe that any leasing bill for the public domain or resources thereof is a direct attack on the sovereignty of the states containing the same, because it must result in a perpetual ownership of the property by the United States Government. Inasmuch as taxes cannot be imposed upon property owned by the Federal Government, it means, to carry it to its ultimate result, the depriving of the states of their means of existence.
>
> I want to call the attention of the committee to a list of the number of acres of land in the various Western States now in the ownership of the Government. In Arizona, 92 per cent. of the lands within the area of that state are in Government ownership; in California, 52.58 per cent.; Colorado, 56.67 per cent.; Idaho, 83.80 per cent.; Montana, 65.80 per cent.; Nevada, 87.82 per cent.; New Mexico, 62.83 per cent.; Oregon, 51 per cent.; Utah, 80.18 per cent.; Washington, 40 per cent.; Wyoming, 68 per cent.

Large Government Holdings in West

Thus it is shown that lands in the several Western States ranging from 40 to 92 per cent. are held in Government ownership and not subject to taxation by the state. And it is proposed by this and other bills pending in the Senate, making up the system of conservation proposed to be inaugurated, to perpetuate this condition and perpetually to deprive the states of the right to tax this large percentage of the land within their borders to maintain and support the state government. Whether the Government has the power to deal with its lands in that way or not, it must be seen by any observing person that it would be a rank injustice to the states in which these lands are situated, apart from the fact that the Government has no right or authority to do this.

As I have stated before, the purpose of this proposed legislation is "to bring about a speedier development of

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Water Power Development

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In one existing development the corporation valued the lands acquired for its developments—dam, reservoir site and plant—at $26,333,000, as evidenced by bonds and stock. A private owner would ask not less than 5 per cent. of the value of such lands as power sites. Should the Government do so? In my opinion it should not, because that would prevent development or impose an undue burden upon the consumer; nor should the Government give away lands worth millions of dollars for power sites, because that would be unwise, unbusinesslike and in derogation of the rights of the general public. Such lands cannot be sold because developers, except in rare cases, could not or would not pay the real value of the lands as power or reservoir sites. If they did, they would endeavor to secure return by imposing higher rates upon the consumers and in that case would doubtless be permitted to impose higher rates by public-service commissions, on the ground that it represented return upon actual investments. To give the lands away is therefore not right. To sell them at their real value is impracticable and would injure the consumer.

Development Under an Equitable Plan

Why not, then, secure development under a plan which would be fair to the developer, the investor, the Government and the consumer by lease or permit for a definite period on conditions fully known in advance? The word "lease" is hardly properly descriptive of the plan which should be adopted. It is not a lease in the ordinary meaning of that term. It is rather a permission to use—a contract or agreement for the development and use of sites.

Careful consideration has been given to the question of what period should be covered by such a permit or agreement, and the general consensus of opinion seems to be that fifty years is the proper one, having in mind the rights and interests of all concerned—this, subject to renewal in the event that the Government or state or municipality does not desire to take over the plant at the expiration of the original permit period, or for good and sufficient reasons it be not found advisable to renew the permit to the original permittee.

As already shown, other governments make such leases or concessions for periods varying from ten to not exceeding eighty years. The State of Kansas provides that franchises to those developing or furnishing electric light, power or heat to any city in that state shall not exist for a longer period of time than thirty years from the date of a grant or extension thereof. The State of Wisconsin authorizes an indeterminate permit and provides for the taking over thereof by a municipality at any time upon due notice and proceedings. The consensus of opinion of those interested in power development seems to favor, however, a fixed and definite permit, rather than the right in the Government, state or municipality to take over the plant at any time during the period of use and development.

It is self-evident, however, that the right should be retained to take over the works upon proper terms and conditions, in order that the same may be taken over and operated by the states or municipalities, and to do this the law and the permit must provide such terms and conditions as will be fair to the permittee and at the same time not forever preclude the exercise of this right by the state or municipality, because of the impossible amounts required to be paid as a prerequisite to the recapture. It is evident that for the use of the public lands to be granted, no payment should be made to the permittee on that account. It is further evident that for lands acquired by the permittee during the course of the development payment should be made, but that payment shall not include the unearned increment created by the community and not by the power developer, nor should it include payment for "good will," franchise values or intangible elements.

The laws of the State of Illinois provide that any city is authorized to acquire, construct, own and operate public utilities and to lease the same for periods not exceeding twenty years. They further provide that there may be reserved in any grant the right to take over all or any part of the property used in operation of a public utility at or before the expiration of the grant, upon terms and conditions provided in the grant, or to grant to a third party, at the option of the city, on the same terms.

The laws of Massachusetts authorize the acquisition by cities or towns of municipal electric plants, upon payment therefor, specifically that the value in so taking over shall be estimated without "enhancement on account of future earning capacity or good will, or of exclusive privileges derived from rights in the public streets."

The State of Wisconsin authorizes the issuance of an indeterminate permit for electrical power, but provides for the taking over of such plants by municipalities at any time, upon payment of just compensation, to be determined by the public-utilities commission and according to terms and conditions fixed by the commission. Every such public utility is required to sell such property at the value and according to the terms and conditions determined by the commission, subject to court review.

The laws of Arizona, California, Maryland, Nebraska, New Jersey, New York and Ohio prohibit the capitalization of any franchise or permit beyond the amount actually paid to the state or to a political subdivision thereof as a consideration of the grant of such franchise or right.

Intangibles Not Recognized

None of the laws of the other states or countries, so far as I have been able to ascertain, authorize or provide for the payment, upon the taking over or recapture of a public utility, on account of good will, franchise value or other intangible elements. Therefore the provisions of the Ferris Bill appear to be, in this respect, in full accord with the general practice.

But the question of the price or consideration to be exacted for these lands still remains to be answered.

As already intimated, a nominal charge of 5 per cent. of the agricultural value of the lands would be useless and inadequate and would not justify the trouble and cost of collection. The gift of such a resource would not inure to the benefit of the consumer or to the general public, but to the promoter. Furthermore, the authorities agree that a charge of some kind should be imposed as a regulative measure. The Government, if it followed the precedent of private owners, could not charge less than 5 per cent. of the value of the lands for power purposes, but this would be a heavy charge upon the developer, which he, in turn, would endeavor to recover from the consumer.

We should charge nothing at first, during the period when the plant is building and finding a market, except,

perhaps, a charge merely sufficient to pay the expenses of administration. This period of nominal charge might be five or ten years. The charge should then gradually and moderately increase as the years go by, according to a scale fixed in the lease or permit at the outset, and in every instance premium should be put on low rates to the consumer. In other words, the lower the rate to the consumer the lower should be the charge on the part of the Government. Some premium should also be placed upon the full development of the power possibilities of a given site.

The main object, however, is to secure development for the benefit of the consumer, and the regulative charge can readily be fixed upon a sliding scale which will go up or down, according to the treatment of the consumer by the producer. In this and certain other respects the Ferris bill (H. R. 16,673) vests some discretion in the Secretary of the Interior. This is necessary and essential, in order that the measure may be workable and may be adapted to the varying conditions of different developments and localities. An arbitrary and fixed rule would, in many instances, work hardships or injustice and prevent development of sites. An examination of the laws of foreign countries and of the several states which have laws governing the operation of public utilities shows that a large amount of discretion is vested in the public-service commissions, governors or other executive officers charged with the administration of such matters.

Excess Returns to Local Improvements

The expenses of administration, which will be smaller than is generally believed, should first be paid. The balance should go to the development of the resources of the states wherein the sites are located and ultimately in part to such states and in part to the general Government.

The vital welfare of most of the public-land states where valuable power sites are located is bound up with power development and irrigation. All returns over administrative expenses should therefore go into the reclamation fund for the irrigation of arid lands. Upon return of the money to the Treasury, as provided in the reclamation law, one-half of the sums so returned should go to the state within the boundaries of which the power is generated and developed.

The Ferris water-power bill seems to meet the present situation as nearly as present knowledge and conditions will permit. It secures development by fixed and certain tenure, by reasonable charge for the privilege given and upon conditions known in advance. It protects the public interests by encouraging low rates to the consumer, by reasonable regulative charges, by contribution to the development of other resources and by ultimate contributions to the state treasuries. It looks to the future by providing that at the end of the fifty-year periods these sites, with their now unknown possibilities and values, may be taken over by the Government to be disposed of to states, municipalities or individuals, or held under such conditions as the future shall disclose to be wisest and best.

In legislation of this kind, there are three principal evils to be guarded against—monopoly, high rates to the consumer and inability to secure restoration of the public lands to public use.

The first evil is guarded against by the specific provisions of the Ferris bill and by the Sherman law. The second is guarded against by the Ferris bill and Federal and state regulation. The last is protected against by the provisions of the Ferris bill, which would become effective in each development at the end of fifty years.

Failure to utilize our water-power resources is an economic waste. Coal, oil, gas and timber which could be conserved for the future or for use in localities where power is not available are now being consumed in places where inexhaustible water power could be developed. Lands which would produce abundant crops under irrigation lie arid and unproductive because of the failure to develop hydro-electric power which would pump water to them. The nitrates in the atmosphere, a source of wealth and a means of providing for the rejuvenation of exhausted soils and of providing an available supply of necessary materials for munitions of war, continue unused because of the lack of cheap and extensive power development. Available capital lies idle because it will not be hazarded upon the revocable permit law. All these conditions and many others which might be set forth justify and call for the enactment of this legislation—legislation which is demanded by engineers, developers and investors; by the general public which would be served by power development; and by all the people in the United States, for all would benefit directly or indirectly from the crops produced and industries created by means of power generated which is now going to waste.

Follies of the Ferris Bill

(Continued from Page 511)

our undeveloped water power." It may be said that this is a purpose not within the power or jurisdiction of the Federal Government. The whole purpose of the bill, as thus stated, is beyond the power of the Government. It has no undeveloped water power. It is only a landowner in the states, and nothing else. The development, as well as the regulation and control of undeveloped water and water power, is purely a state matter. The states alone have power to deal with the subject. The Government may, in its generosity, offer its land to the states as any other landowner might do, to aid the state to develop its natural resources. Constitutionally it can do nothing more.

The assumption of some conservationists that the National Government, as a government, has anything to do with the development of natural resources in a state is without the slightest foundation. As a landowner it may be interested in such development as a means of increasing the value of the land it holds in trust for the people, but nothing more. It may hinder the state in its efforts to develop its resources by withholding its lands, available for dam, reservoir or power sites, or by placing burdensome terms and conditions of sale or lease of its lands, if it has power to lease them, as would make it impossible or impracticable to use them for such purposes. But any private landowner might do the same thing and with the same effect.

And I submit that this is just what Congress will do for the Government if it enacts this bill. The terms upon which the Secretary of the Interior is authorized to lease land for power purposes are so unreasonable and burdensome and so clearly in conflict with state rights and state laws as to prevent any prudent business man from investing any money in a power site in any state. He would be unable to determine whether, in constructing and managing his plant, he would be bound by the Federal or the

state law, or both where they are not in direct conflict. If he obeyed one, in many instances, he would violate the other. A compliance with the state law would, in some cases, forfeit his lease. On the other hand, if he followed the provisions of the lease, particularly as to the time of commencing and completing his plant, he would, in California at least, forfeit his right to the water, the really valuable asset, and a license to use the water would be denied him for failure to comply with the state laws. This would be true in many other states as well.

The present law relating to the use of public lands for power and irrigation purposes is entirely inadequate because of its uncertainty. But this proposed legislation would be infinitely worse, because it is so certainly and fatally wrong. It would, if enacted, soon put an end to any development of water power. Witness after witness, practical and experienced men, appeared before the committee and pointed out that the law would be impractical and unrevokable and prevent investments in enterprises of this kind, and the reasons were clearly pointed out. On the other hand, we had information to the contrary from Government officials who sincerely believed that the law would be beneficial, but they could only theorize about a very practical matter. They had no practical knowledge on the subject. There were others who appeared in support of the bill equally sincere, but without knowledge.

Natural-Gas Pumping Station at Roystone

By Harold B. Bernard*

SYNOPSIS—A combined steam-engine and gas-engine pumping plant supplying towns within a radius of ninety miles. Both high- and low-pressure services are furnished.

During the early days of the natural-gas industry, efficiency and economy of plant operation were neglected, owing to the rapid growth of the natural-gas fields and the low cost of production and operation. In the last decade, however, great strides have been taken toward wiping out this laxity in operation by the installation of large-capacity units, recovery of compressed gas condensate for gasoline manufacture and other uptodate measures found in a well-operated power plant.

Foremost in this campaign of conservation is the Pennsylvania Gas Co., whose Roystone Pumping Station is

*Natural-gas engineer, the Foxboro Co.

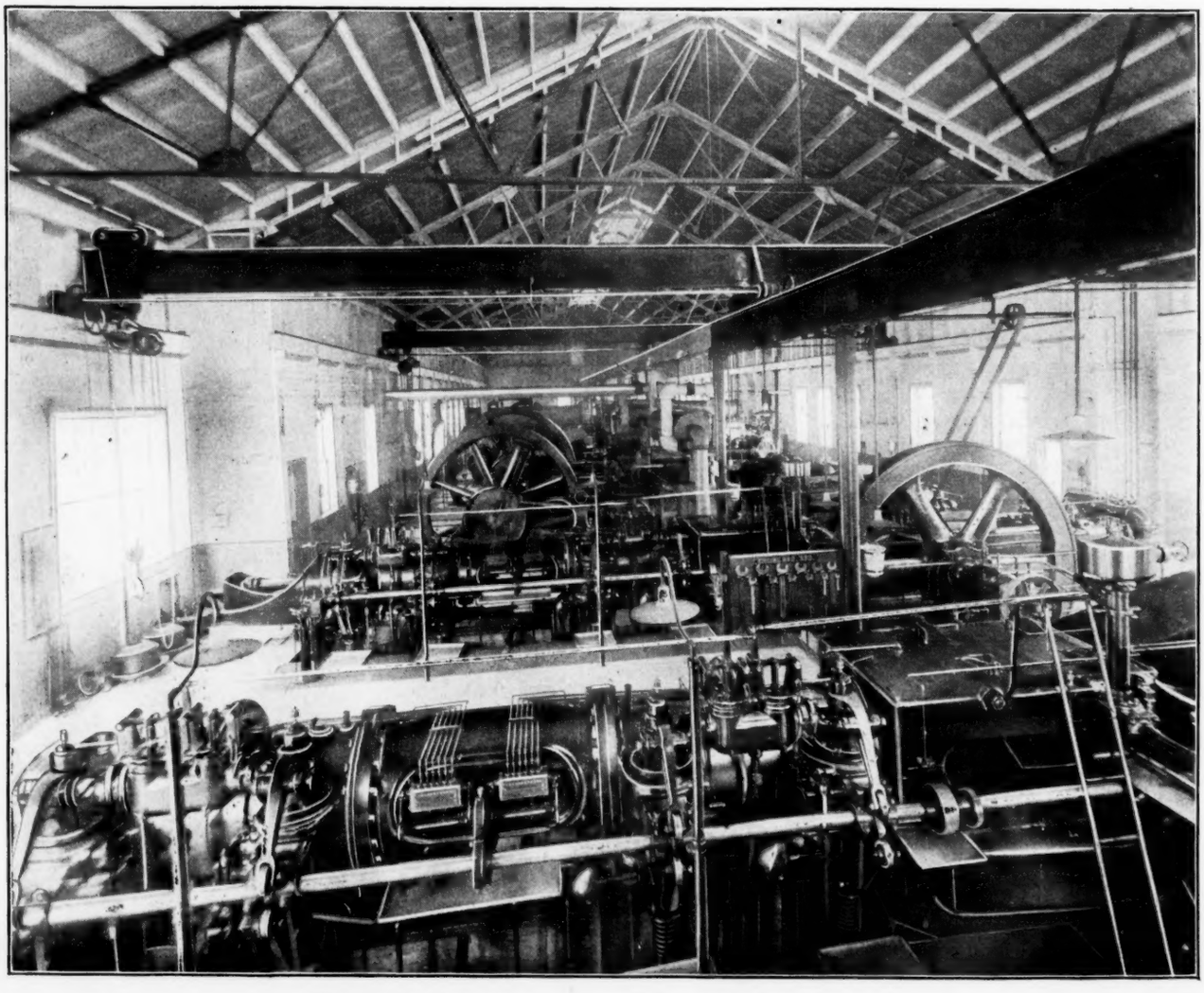
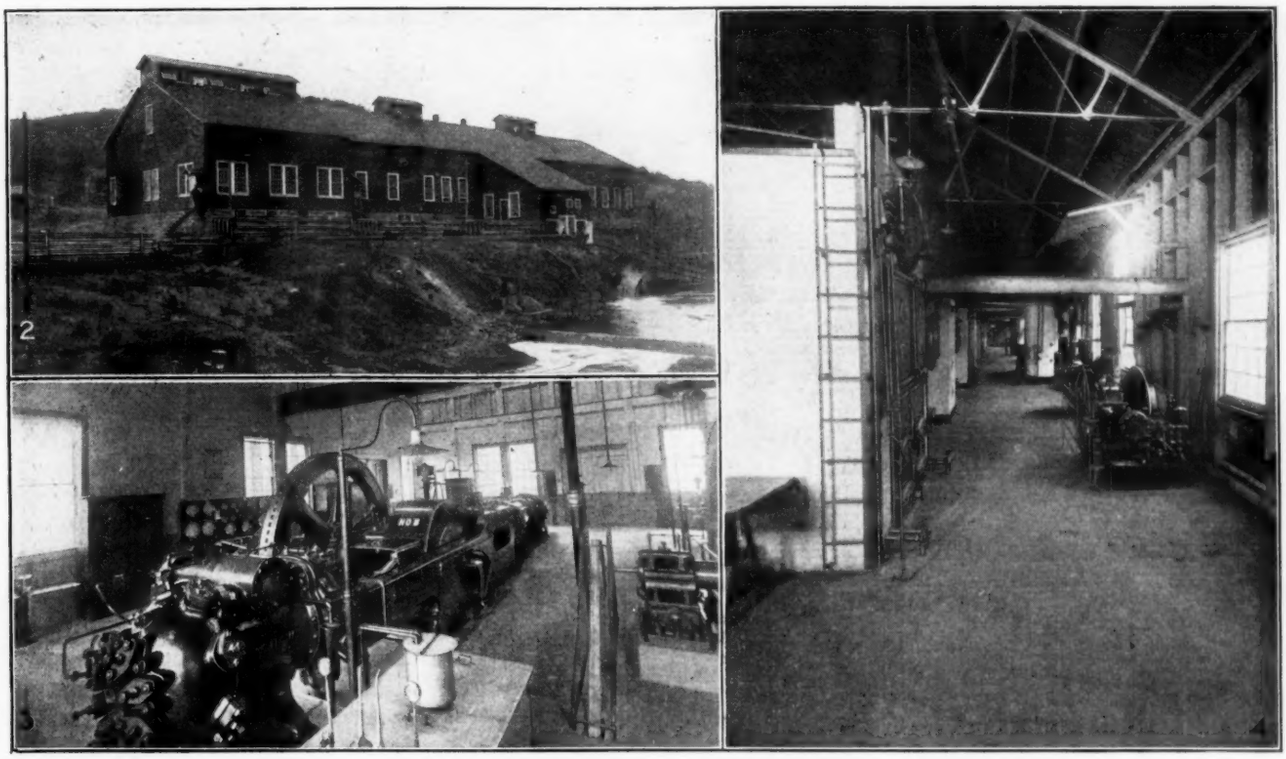


FIG. 1. ENGINE ROOM AT ROYSTONE PUMPING STATION



FIGS. 2 TO 4. VIEWS ABOUT THE ROYSTONE PUMPING STATION

Fig. 2—Plant from creek, showing cooling pipes. Fig. 3—Gas-engine-driven compressor. Fig. 4—Boiler room

numbered among the most efficiently operated natural-gas pumping plants. This station is situated approximately at the center of the holdings of the company, four miles east of Sheffield, Penn., on Two Mile Creek. Gas is delivered to Warren, a distance of 17 miles, through two 8-in. and one 12-in. wrought-iron pipe, and to Corry through two 8-in. lines, continuing to Erie, 90 miles distant, through one 12-in. and one 8-in. line. Jamestown, N. Y., 40 miles from the station, is supplied through one 8-in. line. The line pressure at the station ranges from 150 lb. in summer to 300 lb. in winter. Towns within a small radius of the station and large industrial plants obtain their gas supply from 4-in. lines or by tapping the main line. The 8-in. and smaller lines have screwed connections; the 12-in. lines have plain-end Dresser and Dayton couplings.

Design of Plant

The plant was designed with the view that an engine developing 100 hp. would pump 1,000,000 cu.ft. per day; in other words, that 1 hp.-hr. would pump 416.5 cu.ft. of gas. The total rated horsepower of the plant is 6500 and the delivery pumps are rated at 4400 hp. The maximum peak lead is 40,000,000 cu.ft. per 24 hr., and the average daily winter load 23,000,000 cu.ft., which in summer drops off to 5,000,000 cu.ft.

Six of the eight pumping units are steam-driven cross-compound, operating condensing; the other two are four-stroke-cycle tandem double-acting natural-gas engines, the fuel being taken in before the compressor at atmospheric pressure. The former are supplied with 120-lb. steam by one water-tube and 14 horizontal return-tubular boilers rated at 2400 hp.

Because of tannery refuse in the creek, it is necessary to pipe from near-by springs to an artificial pond at the station, from which feed water and the major portion of the condensing water is obtained. By the installation of jet condensers in place of the surface condensers used formerly, it is possible to use the creek water should occasion demand. The creek also furnishes the supply for the atmospheric condensers through which the compressed gas passes.

Fuel-Gas Analysis

The boilers are gas-fired, with three rows of 17 burners per furnace; provision has been made for a fourth row. The ratios of burner area to heating surface are 1 to 288, 1 to 213 and 1 to 225. The gas has a specific gravity of 0.624 and weighs 47.50 lb. per 1000 cu.ft. The following analysis shows it free from sulphur compounds and ammonia: Methane (CH_4), 80.85; other hydrocarbons, 14; nitrogen (N_2), 4.60; carbon dioxide (CO_2), 0.05; carbon monoxide (CO), 0.40; hydrogen (H_2), 0.10; oxygen, (O_2), a trace; hydrogen sulphide (H_2S), 0; ammonia (NH_3), 0. Its gross heating value is 1065 B.t.u. per cu.ft. at 60 deg. and 30 in. barometer.

The gas used for fuel is received at about 50 lb. and is reduced to 15 lb., at which pressure it is passed through an orifice meter, measuring the quantity consumed by the boilers, gas engines and gas-driven auxiliaries. It is used for steam raising at 5-in. water pressure. The gas is admitted from a header to ¼-in. pipes, reduced to ⅛-in. tips which project into 1¼-in. pipes. Through the annular space formed, air is drawn in at a suction of 0.75 to 1-in. of water. The gas tips are 32 in. from the bottom of the drum, the burner tips 18 in.

As mentioned previously, there are eight compressing units, six steam-driven and two gas-driven, having a combined delivery output of 42,000,000 cu.ft. per day. Three of the steam-driven units are rated at 700 hp. each and

serve as the low-stage pumps, they raise the pressure to 50 lb. per sq.in. The other steam units, rated at 1200 hp. each, together with the gas-driven units, rated at 400 hp. each, serve as the high-stage compressors and discharge against 300 lb. pressure. Gas is received at the station from wells showing anywhere from 5 lb. to 300 lb. rock pressure. The low-pressure gas is taken into the low-stage suction; gas coming in around 50 lb. is admitted to the low-stage discharge and is boosted in the high-stage compressors; high-pressure gas is put directly on the lines. Since the wells may be fed into either suction or the delivery lines, this allows for a sudden heavy pull or the "petering out" of a well.

The gas engines are started on 120-lb. air, which is furnished by a motor-driven compressor. The motor takes its current at 120 volts from a generator driven by a four-stroke-cycle natural-gas engine, which unit also handles the lighting load. A smaller generator driven by a

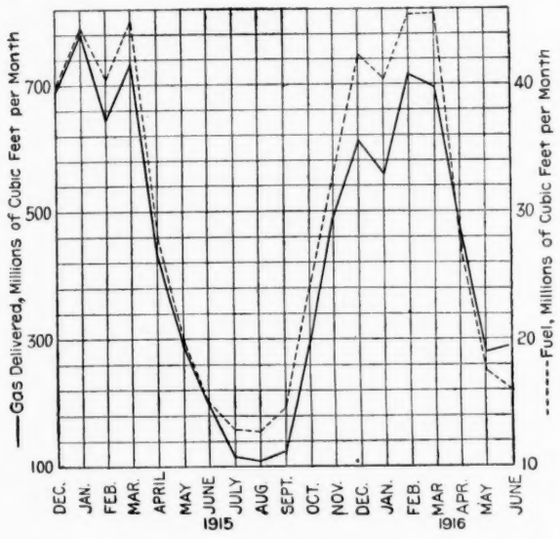


FIG. 5. FUEL AND OUTPUT CURVES

two-stroke-cycle gas engine has been installed for emergency use. A third gas engine drives a fan which supplies hot air to the heating system.

The accurate measurements of natural gas in large quantities has within the last few years claimed considerable attention. Various types of meters have been installed, but on account of their uncertainty of action under varying load and pressure conditions, an efficient substitute was demanded. Through the efforts of Thomas R. Weymouth, an orifice plate and special pitot tubes were designed. At the present writing, the orifice meter has almost entirely supplanted the former systems of measurement. With few exceptions, the meters of the company are of this type. On the suction lines the gas is orifice-metered in the field, except on one line, where pitot tubes having suitable differential and static recorders are employed. The high-stage discharge gas is passed through orifice meters, the recorders being located on a gage board in the engine room. Each day the charts are sent to the engineering department in Oil City, where the suction, discharge and fuel gas is computed. A log is kept of the compressor strokes in order that an efficient check may be had. By comparing the discharge meters with consumers' meters, line leakage is determined.

After leaving the compressors, the gas, which has a temperature of 300 deg. F., passes through a battery of atmospheric condensers of the three-pass type, cooled by creek water. The gas enters at the bottom and between passes goes through cast-iron headers horizontally baffled. The condensate is collected in a tank from which water is drained at intervals. It is forced by gas pressure to a storage tank. By gravity feed it is admitted to the extractor, which is essentially a horizontal still heated by steam coils. A small amount of live steam is injected to assist in carrying over the volatile products of the distillation. In a smaller vessel the used cotton waste undergoes a similar treatment, the vapors formed mixing with those of the condensate and passing through a cooler located in a concrete reservoir. From the condensed liquor the water is drawn off. Oil from the waste and the compressor cylinders, being heavier than the gas, is next taken off. This finds use on roads. The gasoline, which has a specific gravity of 68 deg. Baumé, is stored in tanks and the cotton waste is recovered.

At the present writing little information on cost of plant operation is available for publication. A good estimate of the plant efficiency may be obtained from the fact that in the month of March, 1915, over 700,000,000 cu.ft. of gas was pumped and the fuel consumed amounted to but 6.13 per cent. of it. As an incidental feature, over 0.035 gal. of gasoline was recovered for every thousand feet pumped. Plans have been completed for the erection of a gasoline absorption plant on the main discharge line, to thoroughly "strip" the gas of gasoline. This process does not affect the heating value of the gas, but lowers depreciation on the lines, at the same time recovering a valuable product.

The Rating of Motors

In an article recently published in the *American Machinist* A. G. Popcke gave the following explanation of the rating of motors: For greatest economy, motors and controllers of standard characteristics should be used wherever possible. The standard horsepower and speed ratings furnished by motor manufacturers have been selected at intervals that will make it possible to choose a standard economical motor for the majority of applications met with in industrial service.

All motors are characterized by a rating given them by the manufacturers. This rating is the basis on which the maker guarantees his product to the user. The distinction between motor rating and motor capacity to do work requires a little explanation. The capacity is usually determined by the maximum temperature at which the material in the machine, insulation particularly, may be operated for long periods without deterioration. When the safe limits are exceeded, deterioration is rapid and results in shortening the life of the machine. There does not appear to be any advantage in operating at lower temperatures than safe limits, so far as the life of the insulation is concerned.

Up to the present time it has been customary for manufacturers to guarantee their motors as follows: Continuous service—full rated load continuously, 40 deg. C. rise; 125 per cent. rated load, 2 hours, 55 deg. C. rise.

This means that if, for example, a 10-hp. motor is operated at 10-hp. output continuously, the temperature

of any part will not exceed 40 deg. C. above that of the initial temperature (room temperature = 25 deg. C.); operating the motor at 12.5 hp. for 2 hours will produce a rise in temperature not exceeding 55 deg. C.

Motors for intermittent service are rated on the basis of 5, 10, 15, 30, 60 and 120-min. periods with 55 deg. C. rise. This means that if a motor is run at the rated load during the time period given, its temperature will not exceed 55 deg. C. Thus, a 10-hp. motor rated on a ½-hour 55-deg. basis will not have a temperature rise exceeding 55 deg. if operated ½ hour at 10 hp.

The application of intermittently rated motors is largely based on experience. Past experience with a given application has shown that the motor first selected was either too large or too small. In making the application over again, a motor of capacity more nearly equivalent to the requirements was chosen. Thus, at the present time, manufacturers of machines using electric motors of intermittent ratings to drive them are in a position to specify the motor of proper horsepower and time rating (5, 10, 15, 30, 60 or 120 min.).

A motor required to operate for very short periods at a time, with long intervals between the periods of operation, would be most economically selected on a 5- or 10-min. rated basis. Motors for operating valves, or motors for operating the crossrails, tailstocks or headstocks of machine tools, can usually be rated on a 5- or 10-min. basis.

In crane service experience has shown that a motor rated on the ½-hour basis has sufficient capacity to do the work in this class. A crane motor usually operates continuously all day; that is, it goes through its cycle of operation—starting, accelerating, stopping and reversing—all day long. Thus, a 10-hp. crane motor does not operate continuously at 10 hp. If it did, it would burn up, for it would attain a 55 deg. C. rise in ½ hour, as per its guarantee. In actual service the average capacity is equivalent to perhaps only 3 to 5 hp., whereas its peaks exceed 10 hp.

Experience shows that the maximum permissible temperature to which the insulation of commercial motors can be subjected is 105 deg. C. Investigation shows that the difference between the actual temperature measurable by a thermometer and the actual temperature of the hottest spot is 15 deg. C. Thus, commercial insulating materials will withstand a maximum measurable temperature of 90 deg. C.

Taking into consideration engine-room temperatures, the A. I. E. E. has adopted 40 deg. C. as the basic room temperature. On this basis, therefore, a 50 deg. C. rise in temperature is permissible

The correct application of motors consists in selecting a motor of proper rating for the different classes of service, and this is a subject entirely separate and apart from the responsibility of the maker to produce apparatus that will meet the given guarantees.

Safe Air-Compressor Operation

By M. A. Saller

SYNOPSIS—Some practical instructions are given regarding the safe operation of air compressors. Suggestions pertaining to lubricating compressor cylinders and the danger of using an oil not suited to the requirements are of value in the prevention of explosions in the compressor and pipe lines.

In connection with the installation and operation of air-compressing equipment, there are many factors and considerations that may be overlooked or neglected, and thereby result in extreme hazard to the operators, to say nothing of unsatisfactory operation and poor economy.

Probably the first and most important consideration is the compressor itself. The capacity of the equipment should be adequate to meet the requirements for air at the proper pressure and at normal operating speeds. Extreme overloading results in too high piston speeds, and dangerous velocities through the air valves cause inefficient results and present a source of positive danger. A piston travel of 500 ft. per min., while maintaining full capacity and pressure, should not be exceeded.

Excessive piston speed is often caused by leaky valves and pipe connections, which throw an excessive and unnecessary burden on the compressor. A leak in an air line is just as worthy of attention as a leak in a steam line; therefore frequent inspections should be made to see that they are tight.

The question of flywheel speed should also be given consideration. This is even more important than in ordinary engine work, because of the tremendous strain and high overloads to which compressor flywheels are subjected, owing to frequent and sudden load changes. With a cast-iron one-piece flywheel, a peripheral speed of 5000 ft. per min. should never be exceeded. If the flywheel is of light construction, a speed of 3000 ft. per min. should be the maximum. If the flywheel is made up of flanged sections bolted together, the speed limit should be reduced even further according to the known or calculated strength of the joint construction. In figuring these speeds, the determining factor is the maximum speed of the flywheel when acting under the impulse of the most sudden change of load.

Because of fluctuating and sudden changing of load imposed on a compressor, setting up severe shocks and jars, care should be exercised in locating and building the foundation, which should be of concrete wherever possible, in order to minimize the strains on the equipment itself and to prevent, as much as possible, the transmission of jar and vibration to the building.

Another source of considerable trouble and loss of efficiency is in connection with the condition of the air supplied to the compressors. The air intake should be located where dust and grit are not prevalent. Consideration should also be given to the temperature of the air available, since the cooler the air the less heat will be generated in the compressor. Where dust in the air intake cannot be avoided, arrangements should be made to filter the air through a muslin screen before it is delivered to the compressor intake, or else air-washing apparatus should be installed.

All air pipes in connection with compressing units should be designed with as much care and intelligence as are high-pressure steam lines, both as to capacity and the elimination of avoidable sharp turns. This is to prevent any excessive drop in pressure because of undue resistance in the pipe line, and also to minimize as much as possible vibration or pulsation. Air piping should also be arranged and drained to avoid pockets in which water can accumulate.

Air-Line Temperature

The range of temperature in air lines is frequently very considerable because of varying pressures and compression conditions. The piping should be arranged with provision for the free expansion of all parts, otherwise excessive strains, possibly resulting in rupture, may be placed on different fittings or on the compressor itself.

In steam-driven compressors the rush of live steam into the steam cylinder in response to the sudden changes in load is sometimes dangerous because of the liability of pulling over slugs of water. It is desirable to place a steam separator on the steam line to every unit, both from the standpoint of safety and to assist in securing the best lubrication at the minimum expense for oil, as the elimination of the water in the steam prevents washing the oil from the cylinder walls.

It is desirable to insulate or cover exposed steam or hot-air piping—the former from an economical standpoint to prevent extreme radiation losses, and the latter to protect the burning of operators who may come in contact with the exposed pipes.

Of utmost importance in connection with continuously operating or heavy-duty compressors is that of securing a reliable and generous source of cooling water. Failure of the cooling-water supply in the case of a compressor doing heavy duty will cause overheating and the consequent closing down of the apparatus. In order to know that the cooling water is being supplied, it is advisable to install a flow indicator in the cooling-water line, else arrange the overflow from the jacket so that it discharges into an open funnel where the flow is easily seen.

Cooling Water

The quality of the cooling water is also of importance, because water containing considerable quantities of lime will cause the deposition of scale on the jacket walls, which seriously interferes with the heat exchange and presents a source of expense and trouble when it accumulates to such an extent that it must be removed. Cooling water obviously should not contain acids or other active agents that may cause the corrosion of the jacket lining.

Every air tank, however small, should be fitted with a reliable safety valve set to release at a pressure well within the limits of the strength of the tank and of sufficient size to release all excess air delivered to it, so that there will be no accumulation above the maximum pressure. On large tanks it is advisable to install at least two valves. A drain for drawing off such oil and water as may accumulate should also be provided in the bottom of the tank. It should be opened at regular intervals from three to five times daily, according to the local conditions.

Explosions due to the spontaneous combustion of explosive gases within the compressor cylinder, pipe line or receiver tank present one of the greatest hazards in compressor operation. The responsibility for these explosions can be traced largely to the use of unsuitable lubricating oil, coupled with unsatisfactory operation.

The intense heat encountered in the compressor cylinder affects lubricating oil differently from the heat encountered in the steam-engine cylinder, where moisture is usually present. The dry condition of the air cylinder results in the burning of the oil into powder-like particles, which deposit on the cylinder walls, discharge valves and in the pipe line. This soot, when properly mixed with air, has great explosive tendencies when brought in contact with intense heat, and hence its accumulation is highly undesirable, as the temperature of the compressor cylinder and parts may suddenly be increased, owing to the failure of the cooling water, the clogging of the valve passages because of the soot itself, or the extreme overloading of the compressor.

This accumulation of carbon or soot is either the result of feeding excessive quantities of oil or of the use of a poor quality oil. The oil used in lubricating air-compressor cylinders should be of mineral derivation and should be free of all foreign matter, such as tar, which may tend toward the production of excessive carbon deposits. The oil should also be one with a high flash point; that is, one that will not ignite below 500 deg. The ordinary cylinder oil used in steam engines is not suitable for lubricating air cylinders, and a special grade of oil compounded for the service should be used.

Danger from Oil

As there is a positive danger from feeding too much oil to an air compressor, pains should be taken to see that oil is fed at a uniform rate in just sufficient quantities to give the necessary lubrication. A drop or two of oil every five or seven minutes should be ample for the average machine. A record should be kept of the total amount of oil fed to the compressor each week, so that the feeding of any excess can be checked up.

It is advisable to inspect the cylinder, valves and piping whenever possible—and this should not be at longer intervals than two weeks—and any deposit of carbon and soot should be removed by mechanical means: that is, by scraping or cutting away, or by the application of soapy water or a solution of caustic soda and water. Kerosene or gasoline should never be used for removing carbon.

Compressor explosions are sometimes caused by defective air valves, which allow the compressed air to return to the cylinder, where it is compressed and recompressed until its temperature reaches such a high point that it readily ignites the soot or oil vapors. Inspection, coupled with proper design and construction, should serve to minimize this trouble.

In connection with inspection work it should be remembered that whenever an air-compressor head is being removed care should be exercised in avoiding contact of the escaping gases with a flame, caused by the mixture of the air and vaporized oil, because a flare-up or explosion is liable to occur if the gas happens to be very dense. In all cases where repairs are being made or inspections carried out, the compressor should be allowed to stand for a while to insure thorough cooling of all parts before the work is undertaken.

An aftercooler is used in the air-discharge line for cooling the air after compression, so that any moisture or

oil contained therein will be condensed and separated from the air instead of being carried to the pipe line.

Frequently a fusible plug, containing a mixture that will melt at a certain predetermined temperature (according to the pressure), is placed in the discharge valves. When the temperature rises above the predetermined point, the fusible metal is melted and the air is discharged with a whistling noise, which sounds the alarm that the temperature is rising and hence the valves or cooling water need attention. Recording thermometers installed in the air-discharge line also serve to give notice of undue rise in temperature in that they will indicate when there is a gradual increase in the temperature of the discharged air.

As pointed out, there are many factors in air-compressor operation that require careful and consistent care and attention in order to secure efficient results and to prevent dangerous accidents, and the subject should therefore be considered in all its phases wherever apparatus of this kind is installed and placed in service.

Brady Steam-Jet Ash Conveyor

Some of the features of the steam-jet ash conveyor manufactured by the James A. Brady Foundry Co., of Chicago, are found in the construction of the pipe lines that are made 8 in. inside diameter for capacities of from three to eight tons per hour, depending upon conditions and the number of nozzles employed. The pipe walls are

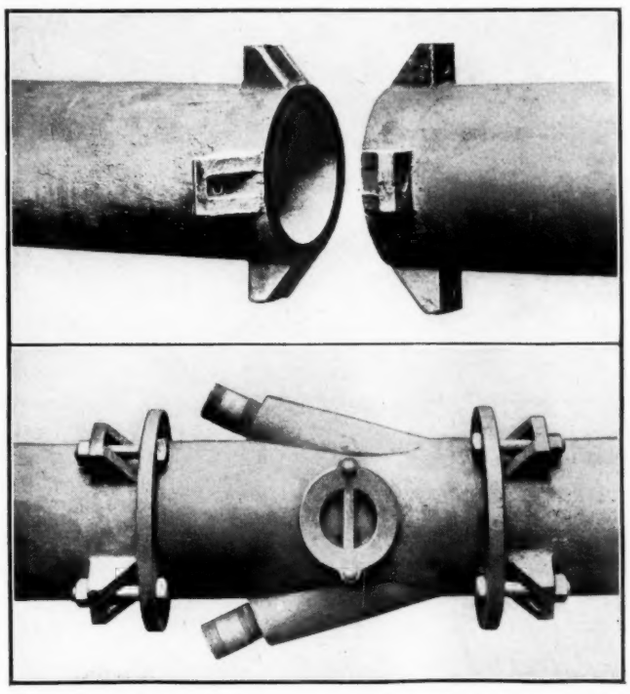


FIG. 1. PIPE-LINE JOINT AND STRAIGHT-LINE STEAM-JET FITTING

cast 1 in. thick, and it is claimed they will withstand the average wear from 60,000 tons of ashes before replacement is necessary. All surfaces where parts fit together are ground flush and bolted without gaskets (upper view, Fig. 1).

Divergent or expansion steam nozzles are used rather than plain nozzles, the former giving higher discharge velocity for the same steam consumption. The nozzles are designed to suit the steam pressure and are usually placed at the top and bottom of the vertical riser in an angle fitting, Fig. 2.

In the bottom fitting the nozzle points upward and the jet of steam enters the fitting in front of and parallel to the face of the wearing back, which is 2 in. thick and may be renewed by removing a cover plate. As the greatest wear is on the upper portion of the wearing back, it is made symmetrical so that it may be changed end for

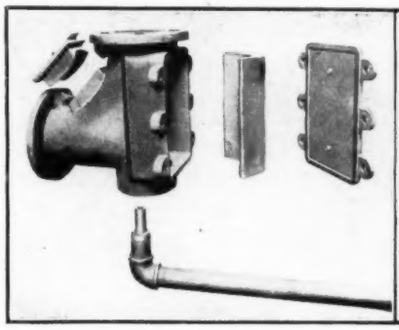


FIG. 2. PARTS OF STEAM-JET ELBOW

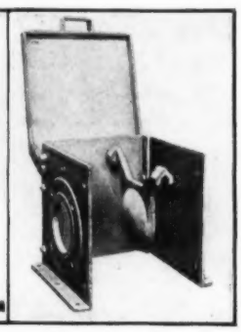


FIG. 3. BAFFLE BOX One side removed

end. On the inner turn of the fitting is a hand-hole plug for inspection of the wearing back or nozzle.

Where the horizontal run in front of boilers exceeds 125 ft., a straight-line steam-jet fitting is used in addition to the nozzles in the angle fittings. This fitting (lower view, Fig. 1) is equipped with two nozzles located at such angles that the steam jets converge at the axis of the pipe. The ash intakes are provided with tight-fitting plugs, the lower part being concave to conform to the inside diameter of the pipe. This latter feature is to prevent eddy currents which reduce the velocity of the air, with consequent reduction in capacity.

At the discharge end of the conveyor, a baffle box takes the impact of the ashes, the latter dropping to the storage pile or tank. If allowed to discharge at high velocity directly into the storage tank, the ashes would pack so tightly that it would be difficult to remove them in the ordinary way through the discharge gate. A swinging baffle, Fig. 3, over 2 in. thick, hangs on knife-edge lugs cast on the sides of the baffle box. This baffle is located at the center of impact and may be inspected or renewed by raising the hinged cover of the box.

When Negligence Will Be Presumed—When it appears that property has been destroyed by a fire originating at a point on the wires of an electric company, which in the ordinary course of events would not happen in the exercise of due care on the part of the company to keep its wires in proper condition, the burden falls on the company to disprove negligence on its part contributing to the fire; in such case the suing property owner is not bound to affirmatively prove specific act of negligence on the company's part. (California District Court of Appeals, Silva vs. Northern California Power Co., 162 Pacific Reporter, 412.)

Liability of Electric-Power Companies—An electric-power company which furnishes electricity to consumers, wiring their buildings and furnishing apparatus for utilization of the current, is bound to use all reasonable care in insulating the wires and otherwise minimizing danger to persons required to be near such wires and appliances. (Oregon Supreme Court, Clayton vs. Enterprise Electric Co., 161 Pacific Reporter, 411.) In this case the court has affirmed judgment against defendant for death of an employee in a pumping plant, who was electrocuted while operating a defective switch which controlled a motor pump; defendant having undertaken to furnish decedent's employer with electricity and necessary appliances to operate the plant.

Reconnecting Induction Motors—Diagrams of Open-Slot Windings

By A. M. Dudley

SYNOPSIS—The types of connections used in open-slot windings are discussed, and sufficient examples are given to make it possible to lay out diagrams of these windings when such diagrams are not immediately available.

In earlier articles were shown examples of the method of connecting windings which are used in partly closed slots having overhanging tooth tips. These windings are usually called "bar-and-end connector," "pushed-through" and "hand-wound." The greater proportion of motors built according to present-day designs have open slots in the core of the stationary member and are wound with form-wound, completely insulated coils of the well-known "diamond type."

It is the object of this article to explain the method of connecting up these open-slot windings with sufficient examples to make it possible to lay out such a diagram when one is not immediately available. It should be borne in mind that such diagrams can also be used with partly closed slot windings when they are of the same form as "diamond coils." Such for example are the so-called "fed-in" or "dropped-in" coils, which are really "diamond" coils except that they are placed in partly closed slots, one wire at a time, through the small opening at the top of the slot. Such also are the strap coils referred to earlier, where the slot is half open and the tooth tip overhangs from one side. While there are four separate coils in such a slot, each coil is insulated from ground and for purposes of connecting up may be

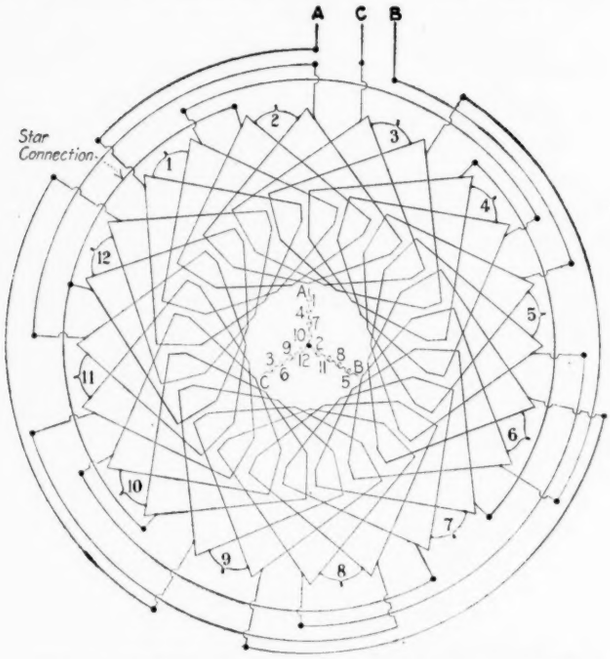


FIG. 1. THREE-PHASE, FOUR-POLE, SERIES-STAR WINDING

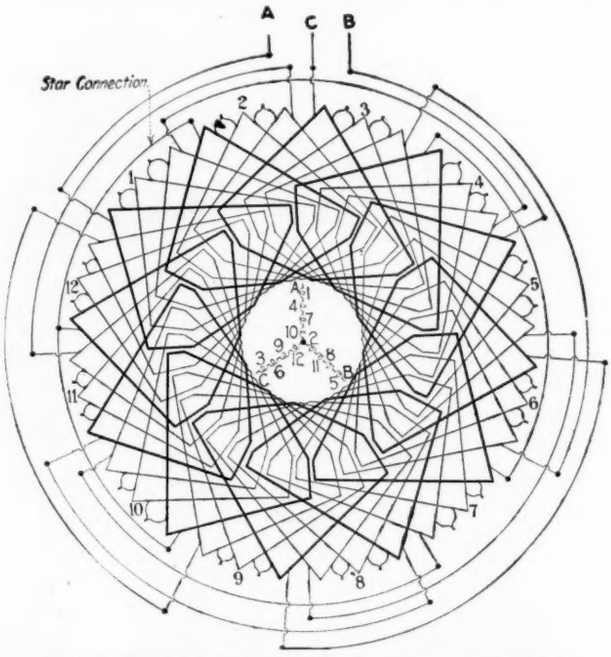


FIG. 2. THREE-PHASE, SIX-POLE, SERIES-STAR WINDING

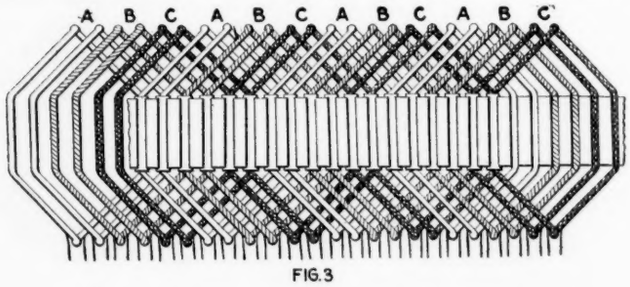


FIG. 3

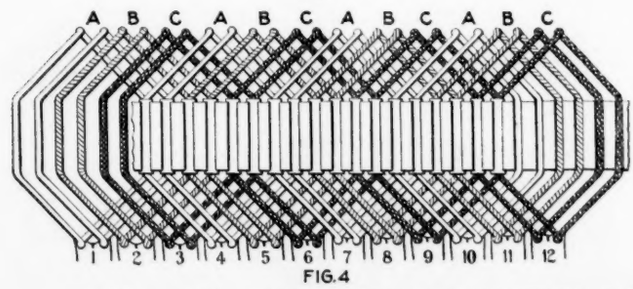


FIG. 4

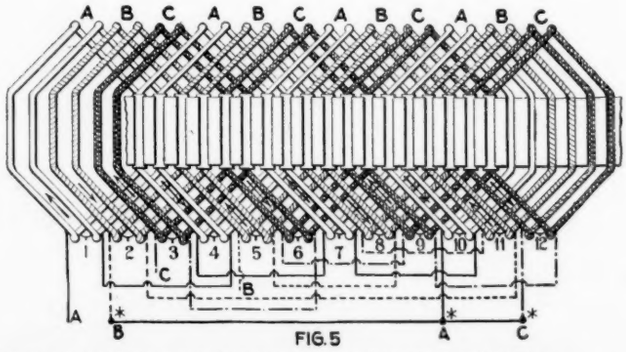


FIG. 5

FIGS. 3 TO 5. ILLUSTRATE THE SUCCESSIVE STEPS IN MAKING THE CONNECTION SHOWN IN FIG. 1

considered the equivalent of an open-slot winding laid in twice the number of slots. Such a winding is shown in Figs. 8 and 20 of the second article of this series (Feb. 20 issue). Bar-and-end connector windings when of the "lap" and not the "wave" type are also connected in the same manner.

A completely developed picture of an open-slot winding is shown in Figs. 1 and 2. The straight radial lines are shown in pairs. These radial lines represent the straight parts of the "diamond" coils. The shorter line of each pair represents the side of the coil lying in the bottom of the slot and the longer line the side of the coil in the top of the slot. Taking Fig. 1, for example, before any cross-connecting was done there were 24 separate coils with the beginning and ending of each coil projecting at the end of the winding as shown in Fig. 3, which is the winding represented in Fig. 1 in place in the stator slots laid out flat. Since it is to be connected for three-phase four poles, there is a total of $3 \times 4 = 12$ pole-phase groups required and this results in $24 \div 12 = 2$ coils per group. The first step, therefore, is to connect the coils in pairs, each pair forming a pole-phase group, as in Fig. 4. These coil-to-coil connections, or stubs, are shown at the group numbers. The resulting 12 pole-phase groups are then cross-connected to form the completed winding as in Figs. 1 and 5.

A comparison of Fig. 1 with Fig. 2 shows that the cross-connections or pole-phase-group connections are identical, the only difference between the two being that Fig. 2 has 36 coils total instead of 24 and hence there are three coils in each pole-phase group instead of two. The coils shown in heavy lines, Fig. 2, represent the coils having heavier insulation, where the phases change between adjacent coils and will be referred to in a later article. A consideration of these figures leads at once to two conclusions: First, that such a form of diagram as Figs. 1 and 2 is entirely too complicated for use by the average winder and a diagram like that in Fig. 5 requires too much time to make and is therefore too expensive. Second, since the actual cross-connections themselves are not affected by the number of individual coils in the pole-phase group, the entire picture shown in Figs. 1 to 5 may be replaced by the simple diagram shown in Fig. 6. The spiral lines representing the pole-phase groups, which are numbered to correspond with Figs. 1, 4 and 5, can be imagined as being the coils which form the pole-phase groups. It is obvious that there might be any number of coils connected in series to form the groups. If, for example, the complete machine instead of having 24 or 36 slots had 48, 60, 72 or 96 slots, the cross-connections of the groups in any case would be as shown in Fig. 6. A diagram of this type is therefore always used for such windings, since it can be used for any three-phase four-pole machine independently of the number of slots in a particular machine.

Attention is called to the small "Y" diagram in the center of Figs. 1 and 2 which is also reproduced in Fig. 6. It has no electrical connection with, but is the "schematic equivalent" of, the rest of the diagram. It is the designing engineer's imaginary conception of the cross-connections reduced to their simplest terms. By comparing the numbers of the groups on this small diagram with the corresponding numbers on the larger diagram,

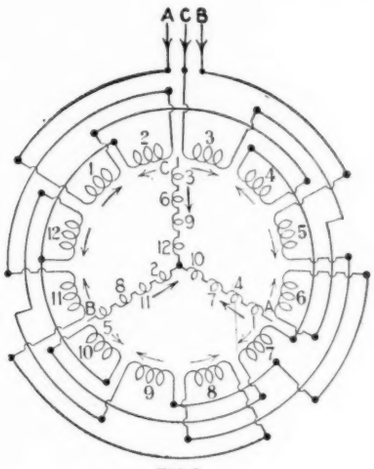


FIG.6

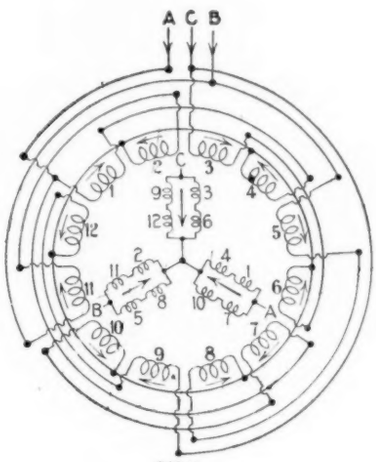


FIG.7

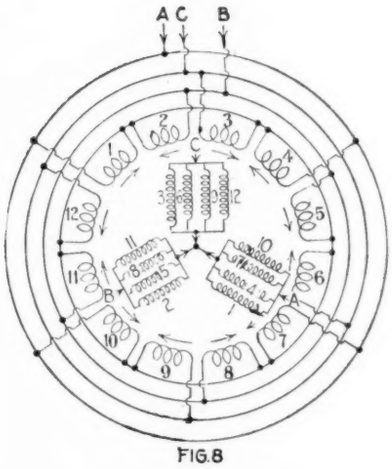


FIG.8

FIG.9

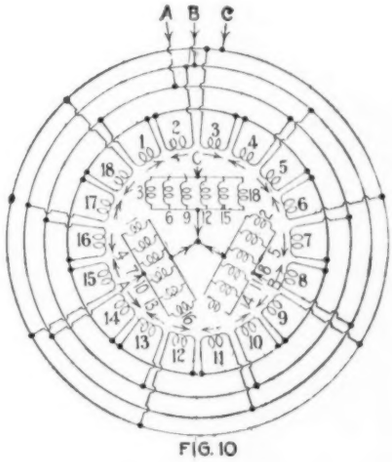


FIG.10

FIGS. 6 TO 10. DIFFERENT WAYS OF GROUPING THREE-PHASE INDUCTION-MOTOR WINDINGS

Fig. 6—Three-phase, 4-pole, series-star. Fig. 7—Three-phase, 4-pole, 2-parallel-star. Fig. 8—Three-phase, 4-pole, 4-parallel star. Fig. 9—Three-phase, 6-pole, 3-parallel-star. Fig. 10—Three-phase, 6-pole, 6-parallel-star

it will be seen that each pole-phase group is shown in its proper phase and with the proper direction of its ends toward the lead or toward the star connection. The arrows shown on the larger diagram, Fig. 6, and also on the small schematic equivalent represent a simple and positive check as to whether the connections to the different groups are correct.

There is a danger in a three-phase winding that the three phases may be connected in a 60-deg. relation instead of a 120-deg. relation, or as it might be expressed on the diagram Fig. 6, there is danger that the wrong end of the *B* phase, for example, may be connected to the star point. As a check against this each phase is traced through, starting from the lead or terminal and proceeding to the common, or "star," point at the center of the winding. As the successive groups are passed through, an arrow is placed on each as shown, indicating in which direction that group was passed through. When all three phases have been traced through and the arrows on the groups are inspected, the diagram is correct if the arrows on adjacent groups reverse; that is, if they are alternately clockwise and counterclockwise in passing around the winding. This check should be studied over and thoroughly mastered, as it is the one check that the author has found in 15 years of practical experience is always reliable and easily applied. The only exception to this check is the case of consequent-pole machines, to be described in the next article, but these are so special and so infrequently met with that they may be practically put out of the consideration and the check be regarded as almost universal.

It is the common practice of all manufacturers to send out machines that can readily be connected for either one or two voltages. This is accomplished by a series or parallel arrangement and can be understood by comparing Figs. 6 and 7. By looking at the small "equivalent" diagram in the center, it will be seen that there are twice as many groups in series between the terminal leads in Fig. 6 as there are in Fig. 7. This means that if Fig. 6 is proper for 440 volts, Fig. 7 would be right for 220 volts. The idea was given in an earlier article (Jan. 16 issue) that one function of the winding was to generate the counter-electromotive force. It can be seen at once that if the coils as connected in Fig. 6 are generating 440 volts, they will obviously generate only half as many, or 220 volts, connected as in Fig. 7. As another consideration, it is seen that if the motor has the same horsepower at both voltages, it will have twice the number of full-load amperes at 220 as it has at 440 volts. This is properly taken care of, as will be seen from Fig. 7, since the winding being doubled has twice the copper cross-section in Fig. 7 that it had in Fig. 6.

If the number of poles in the machine is divisible by 4 as, for example, 4, 8, 12, 16, etc., the winding may

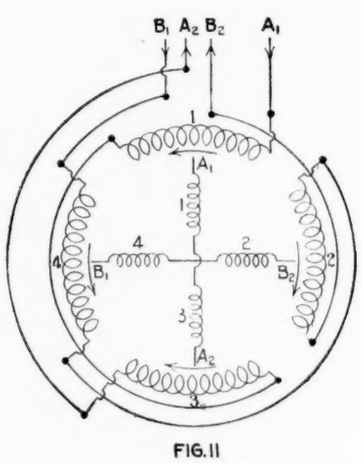


FIG. 11

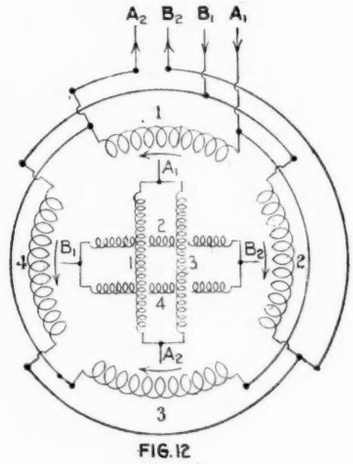


FIG. 12

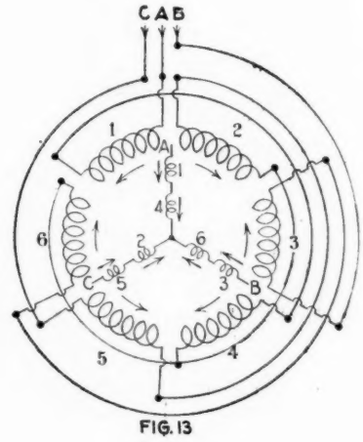


FIG. 13

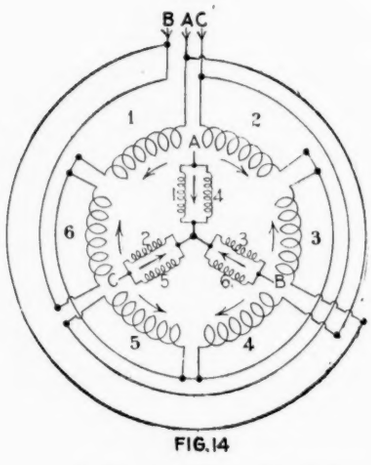


FIG. 14

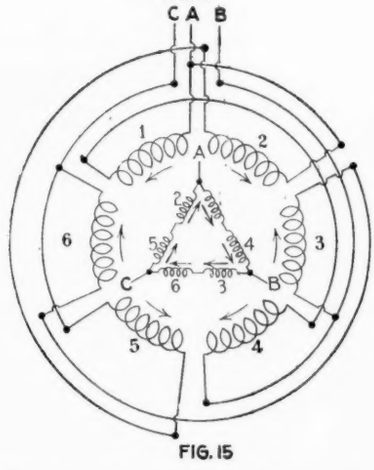


FIG. 15

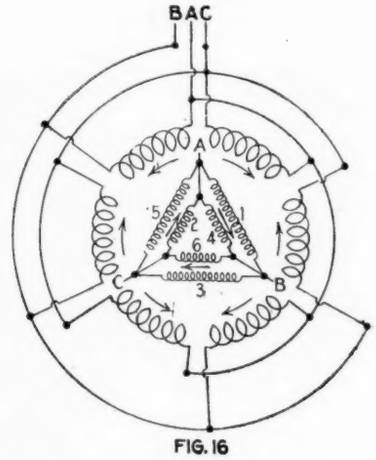


FIG. 16

FIGS. 11 TO 16. DIFFERENT WAYS OF GROUPING A 2-POLE WINDING FOR TWO- OR THREE-PHASE

Fig. 11—Two-phase, 2-pole, series. Fig. 12—Two-phase, 2-pole, parallel. Fig. 13—Three-phase, 2-pole, series-star. Fig. 14—Three-phase, 2-pole, parallel-star. Fig. 15—Three-phase, 2-pole, series-delta. Fig. 16—Three-phase, 2-pole, parallel-delta

be put in 4 parallels as shown in Fig. 8 and by comparison with Figs. 6 and 7 would be good for 110 volts at the same horsepower. The increased current at 110 volts is again taken care of by providing 4 times the copper section, as shown. This same principle can be extended, and when the number of poles for which the machine is wound can be divided by 6, it is possible to have the winding connected for 3 parallels or 6 parallels, as shown in Figs. 9 and 10, respectively. If divisible by 8, there could be 2, 4 or 8 parallels, and if divisible by 10, there could be 2, 5, or 10 parallels. It will be explained in a later article on "Changes in Voltage" that these possible changes when considered with the possibility of "star" or "delta" allow in many cases the reconnecting of motors for new conditions. As regards the number of possible diagrams, these multiply very fast. As an instance are shown the diagrams, Figs. 11, 12, 13, 14, 15 and 16. Here the simplest case is studied—that of two poles—and when two- and three-phase are considered, series and parallel, and star and delta, there are six possible diagrams of connection, as indicated. Considering for the moment a 12-pole winding, there are possibilities for series, 2 parallel, 3 parallel, 4 parallel, 6 parallel and 12 parallel groups, which with two- and three-phase and star and delta give 18 diagrams total, just for 12 poles. It becomes plain that it is desirable to analyze these diagrams and arrive at a simple scheme by which any one can be drawn at need without the necessity of relying on a bulky collection of diagrams which may not be available when needed. In Figs. 17, 18, 19 and 20 is shown the method of laying out diagrams of this general nature. The first operation in making the connection is to connect the individual coils into pole-phase groups. There are as many coils in series in each group as the total number of coils in the winding divided by the number of phases times the number of poles. In Figs. 17 and 18 this is assumed to be 4 coils, and hence each pole-phase group is shown as having 4 individual coils in series. The next step, as shown in Figs. 17 and 18, for a two-phase machine is to letter the alternate groups *A*, *B*, *A*, *B*, etc., to designate the groups in the *A* phase from those in the *B* phase. The next step is to put on the arrows, as shown, in groups of two pointing in the same direction on two successive groups of coils. It does not matter what group is used to start with. The only essential is that there shall be first two arrows pointing clockwise and then two arrows pointing counterclockwise. The third step is to show the connections to the different groups so that the current at any given instant will pass through the groups in the same direction as the arrows. If this method is followed in laying out the connections of two-phase windings, the result will always be a diagram that shows the pole-phase groups connected in their proper relation.

Fig. 18 is produced to compare with Fig. 17 to verify the statement already made that the arrows may be placed beginning with any group. In Fig. 17, beginning at the right, there are two arrows counterclockwise on groups 1 and 2, whereas in Fig. 18 the first two arrows counterclockwise are on groups 4 and 5. The only effect of this is to reverse the *B* phase, or in other words, the motor in Fig. 18 would have the opposite rotation of the motor in Fig. 17. Since this is at once corrected by reversing the leads of one phase outside the motor, it will be seen that if the internal connections are made according to Fig. 17 or 18, the motor will operate properly in all respects.

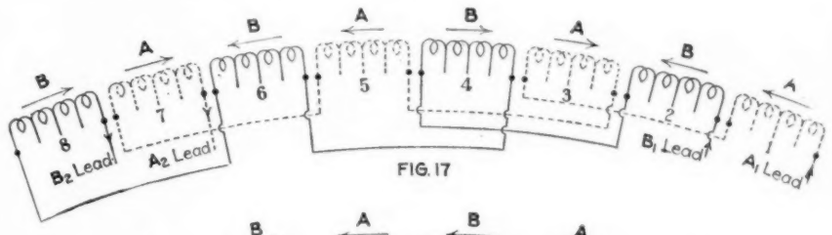


FIG. 17

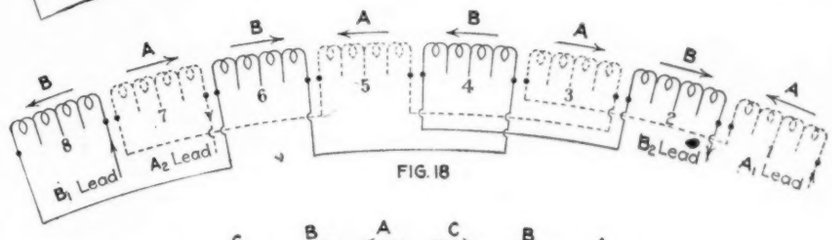


FIG. 18

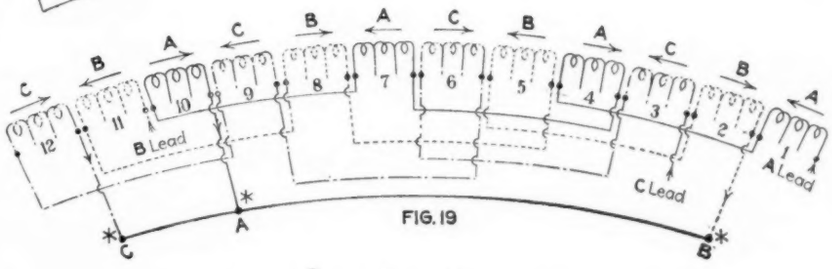


FIG. 19

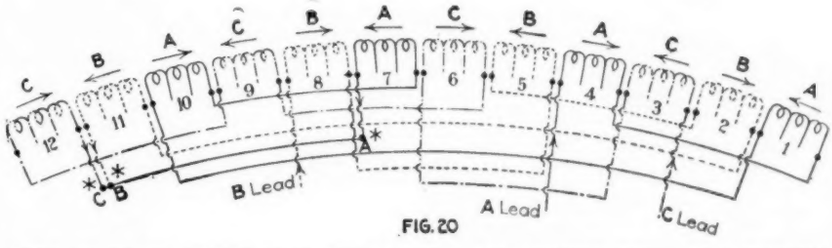


FIG. 20

FIGS. 17 TO 20. SHOW HOW TO LAY OUT AND CHECK TWO- AND THREE-PHASE CONNECTIONS

The three-phase winding shown in Fig. 19 is even simpler. Here there are 3 coils per pole-phase group, and as in the two-phase winding the individual coils are first connected into pole-phase groups and the groups lettered consecutively *A*, *B*, *C*, *A*, *B*, *C*, to separate the phases. Then the arrows are put on as shown, first clockwise and then counterclockwise, alternately, beginning with any convenient group, it matters not which. The lines are then drawn in for the group connections as shown, following the convention that the arrow enters the lead or terminal of each phase and goes toward the star or common connection at the center of the winding. If this rule is followed, the connection will be correct and it is applicable to any combination of numbers of slots and poles. By keeping in mind either Fig. 17 or Fig. 18 for two-phase and Fig. 19 for three-phase, all diagrams of

this type are mastered and can readily be reproduced at a moment's notice.

In checking a delta diagram, check it first as if it were a star diagram and then form the delta by connecting the star end of the A phase to the B lead, the B star to the C lead and the C star to the A lead. These three connections will be the delta points from which the three external leads are brought out. Another method of checking where it can be handled without confusion is to imagine the current flowing around inside the closed delta. The arrows on adjacent pole-phase groups will then alternate in direction as in the check on a star winding. This latter check may be applied to Figs. 15 and 16 by starting from terminal A, or any terminal for that matter, and following around through all the pole-phase groups back to A. For example, in Fig. 15, starting from A terminal, follow through group 1, then through 4, 3, 6, 5 and 2 back to A; thus a closed circuit has been made through all the groups in the direction of the arrows.

A further consideration of the arrows on the pole-phase groups of Fig. 19 shows that there might be a number of different connections, all correct, which check with these arrows and differ only as to the particular group from which the lead or the star connection are taken off. In fact, the lead or the star connection may be taken off from the proper end of any pole-phase group in a given phase so long as the cross-connections, when followed through, give the alternate arrows as shown. Fig. 20 is added to show one of these possible connections just as correct as Fig. 19, but with the leads and stars taken off from different pole-phase groups. Referring to the winding, Fig. 5, and again applying this rule, it will be found to hold good as indicated by the arrows. This demonstrates conclusively the correctness of this method of checking three-phase diagrams of this type.

Mono Firemen's Premium System

By F. D. Harger

SYNOPSIS—This article explains a premium system whereby the firemen are paid a bonus for the time during their shift when the CO_2 in the gases going to the stack are within certain limits, no bonus being paid when the bounds are exceeded. The premiums are based on the heat losses of the products of combustion, not on the amount of coal fired.

To many a plant owner the idea of a premium or bonus system may seem impossible, yet the fireman's efficiency nowadays depends upon the wages he receives, and an extra bonus paid above the normal hourly wage is encouraging to the crew and is looked upon as rewarding a man according to the quality and not on the quantity of his work. Fig. 1 shows graphically about what percentage of the heat units in the fuel, as fired in the average small steam plant, is absorbed by the boiler. As every heat unit gained by the fireman increases the economy, it is important that he become interested in the betterment of combustion conditions.

A premium should not be based on the quantity of coal shoveled into the furnace, but on the economical result obtained. With a bonus system the fireman's bonus increases with a decrease in coal consumption. Such a system would at first glance seem to be impracticable because of the difficulty of determining how much water is evaporated per pound of coal. Besides, it would not take into consideration the efficiencies and other conditions of the various plants, and thus a good fireman in a badly managed plant would be treated unfairly. One way for a just and practical application of the idea is to base the premium upon the heat losses of the products of combustion. As these losses can be controlled by measuring the CO_2 in the exit gases, the premium can be made proportional to the losses of heat up the chimney.

Generally speaking, with a hand-fired boiler, the best economy is produced when the CO_2 lies between 10 and 12 per cent. In boilers provided with mechanical stokers, very good economy is generally obtained with 11 to 13 per cent. CO_2. This condition varies to a certain extent in the different plants and will have to be determined by a series of Orsat tests.

In order to gain the confidence and the interest of the boiler-room staff, such a system must be supported by a dependable continuous CO_2 recorder. If the apparatus records incorrectly, the basis of the premium determination is gone and the premium does not correspond to the care and attention which the firemen will give the fires.

The apparatus must show the fireman at all times his own record, and he should have access to the result, so that he may be able to remedy any faults in his methods so far as firing is concerned. The principle of the Mono premium system is as follows:

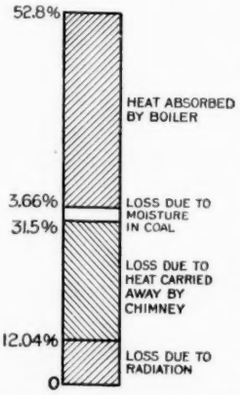


FIG. 1. SHOWING HEAT DISTRIBUTION

If it is assumed that in a certain boiler room 11 per cent. of CO_2 in the flue gases has been determined as giving the best economy, then the firemen will get a premium for the time during which they maintain the 11 per cent. of CO_2, allowing them a leeway of 1 per cent. above or below 11 per cent. For the time during which they deviate from this margin to an extent of $\pm$ 3 per cent.—that is, if they obtain a CO_2 percentage of either 8 to 10 or 12 to 14 per cent.—no premium is paid. However, if the percentage of CO_2 deviates more than 3 per cent. in either direction from the 11 per cent. standard, then the time during which such condition is incurred is deducted from the time for which the firemen would receive a premium.

A rule to be used with the records made by the Mono instrument (a detailed description of this instrument was published on page 46 of the Jan. 9 issue) is divided into three parallel fields of even

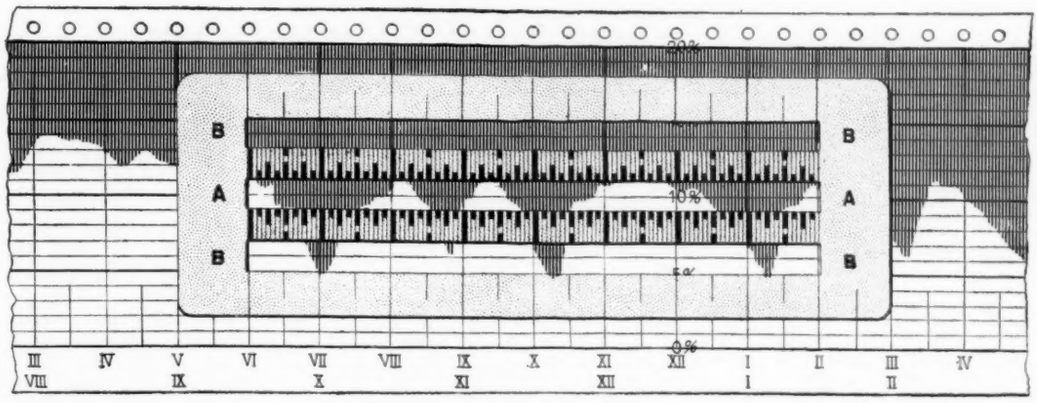


FIG. 2

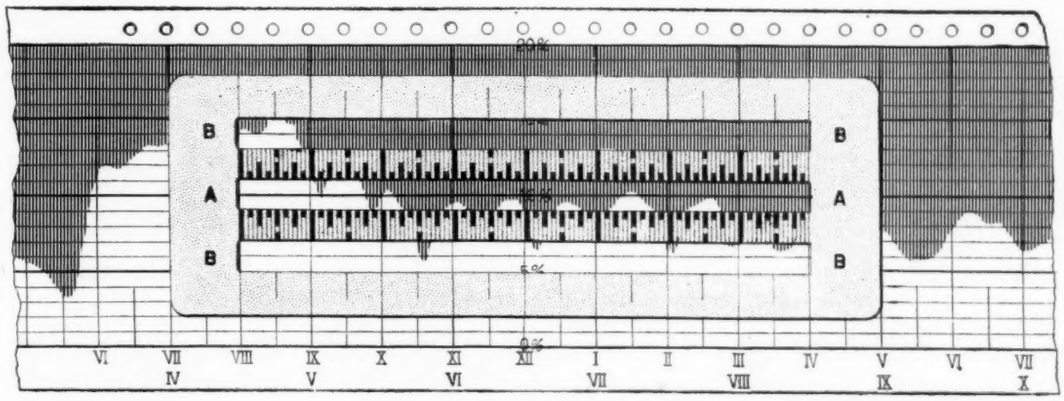


FIG. 3

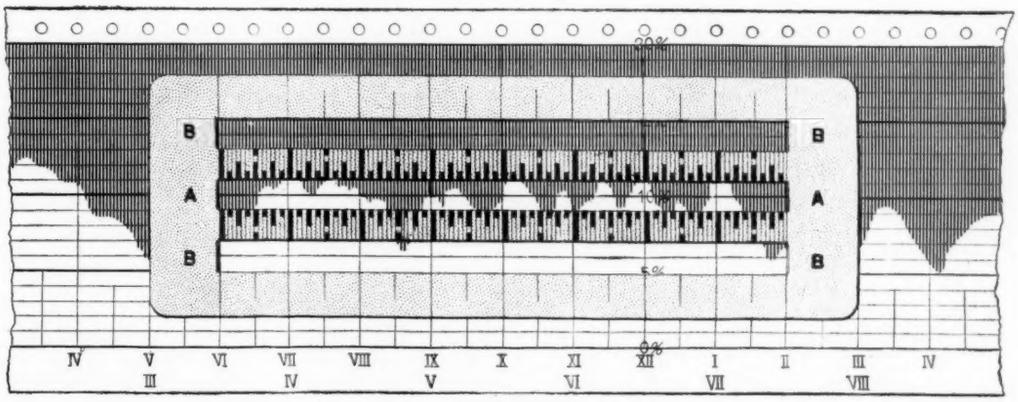


FIG. 4

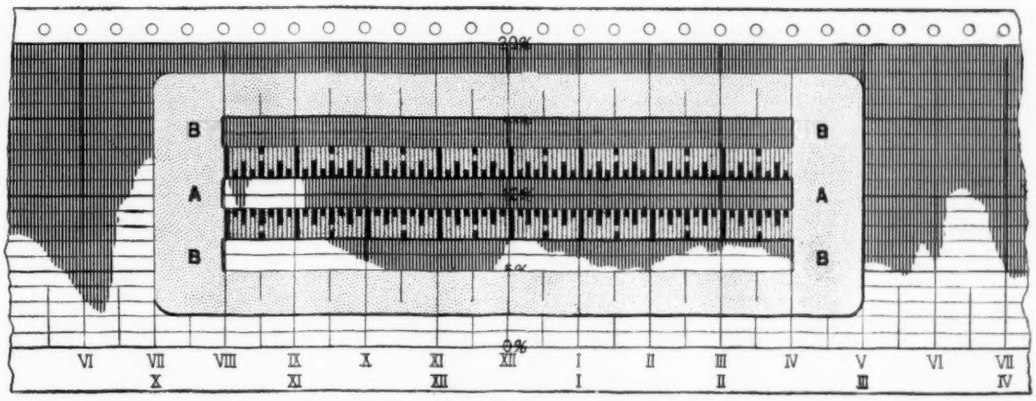


FIG. 5

FIGS. 2 TO 5. EXAMPLES SHOWING USE OF THE MONO RULE

areas (Fig. 2). The center one is called the A field and the upper and lower ones are called B fields. The rule has the hours marked in the same manner as the chart furnished by the recorder, and each hour is subdivided into 16 equal parts or points.

For the calculation of the diagram the rule is laid over it so that the field A leaves open the margins fixed as giving the most economical results in the individual plants—generally between 10 and 12 per cent. CO_2. It thus covers up the percentages 8 to 10, also 12 to 14. The time during which the fireman obtains these latter percentages is of no interest as it does not enter the calculation. The B fields, comprising the percentages below 8 and above 14 per cent., are open, and the time during which the analysis lines run into these fields is deducted from the time during which the fireman maintains the CO_2 within the A field. This means that all analysis lines terminating in the A field count for the fireman and all lines terminating in the B field count against him.

Using the Rule

Without disturbing the position of the rule, one adds together all lines terminating in the upper B field—that is, all lines above which the chart shows white—and in the same manner in the lower B field all points below the rule that show black. (Red ink, however, is used to make the record on the chart.) The sum of all these points in these two fields are the B points. The single analysis lines on the chart are not counted, but the division points on the rule (the $\frac{1}{16}$th hour divisions) are laid out with alternate white and black bars, the latter of uneven lengths so as to facilitate the counting. The difference between the A and the B points is called the premium points.

The rule is worked out for eight hours and may be used for any shift length.

Example 1: In one plant 10 per cent. of CO_2 gives the most economical furnace conditions. The number of the $\frac{1}{16}$th hour divisions (points) in the A field (Fig. 2) are $A = 63$. During this time the CO_2 was maintained between the limits of 9 and 11 per cent. The number of points in the upper B field are none. In the lower B field, however, there are 21. Hence $A - B =$ premium points; $p = 63 - 21 = 42$.

Other Examples

Example 2: Fig. 3 shows that $A = 44$ and $B = 25$ (both B fields are added together; there are 10 B points in the upper and 15 in the lower field), hence the premium points $p = 19$.

Example 3: Fig. 4 shows that $A = 67$ and $B = 10$, hence the premium points $p = 57$.

Example 4: Fig. 5 shows that $A = 5$ and $B = 69$, hence there are no premium points to count.

From the premium points p is calculated the amount of the premium payable, as well as the classification of the work of the fireman, hereinafter called the fireman factor. This factor is expressed in percentages and is calculated for such time as the fireman can maintain the percentage of CO_2 within given and predetermined limits after due deductions are made for the time during which he deviated from these limits more than $\pm$ 3 per cent., as previously explained. If the number of A points as well as B points and the time T are known, then the fireman factor E can be calculated with the following equation:

$$E = \frac{(A - B) + 16 \times T)}{32 \times T} \times 100$$

which means that if all analyses would terminate in the A field, we would find the fireman factor to be

$$E = \frac{128 + (16 \times 8)}{32 \times 8} \times 100 = \frac{128 + 128}{256} \times 100$$

$$= 100 \textit{ per cent.}$$

Therefore E decreases with a decreasing number of A points and rising number of B points.

As an example, figure the fireman factor E for Example 1 already cited, where $A = 63$, $B = 21$ and $T = 8$:

$$E = \frac{(63 - 21) + (16 \times 8)}{32 \times 8} \times 100 = 66 \textit{ per cent.}$$

The other examples are worked out in the same manner.

That the fireman factor E can never read 100 per cent. is evident, and the maximum limit of the efficiency not only depends on the quality of the fireman, but also on the load conditions of a particular plant. Tests made in a number of industrial plants using various types of boilers and working under all kinds of load conditions have shown that the maximum fireman efficiency may vary between 55 and 85 per cent. The lower figure was found to be in plants with constantly varying load conditions, the higher one in those where the load conditions were more or less constant.

Calculating Premium

For calculating the premium to be paid, the number of premium points are determined and for each of these points the fireman receives a certain fixed bonus, or premium, p, which stands in a definite proportion to the saving of fuel due to careful firing. Generally speaking, the fireman can reduce the fuel bill about 10 per cent. by careful stoking, and therefore the premium should consist of at least 10 per cent. of this fuel reduction. Provided that he is firing the boilers in such a manner that the highest possible fireman efficiency is reached in a certain plant, then he would receive a premium equal to 1 per cent. of the value of the amount of fuel which is consumed during his shift. Thus in the same manner as his efficiency, or E, falls off the premium also decreases until E falls to 50 per cent. or below, in which case no premiums are paid.

The premium per point and in proportion to the size of the plant can be determined in the following manner: Assume as an example, a coal consumption of 50 lb. per 100 sq.ft. of boiler-heating surface per hour at $4 per ton; then for each 1000 sq.ft. of heating surface there would be an expenditure of $1 for each hour of the run. As said before, if the fireman reaches the highest possible efficiency, he would receive a premium of one-tenth of the monetary value of coal consumed during his shift, which would be in this instance $0.10. Assume that the maximum efficiency of a man in this plant reaches 55 per cent. and that his working hours are 10 and insert this in the formula, then

$$E = \frac{(A - B) + (16 \times T)}{32 \times T} \times 100$$

then premium point $A - B = 16$. Thus the premium per premium point must become $0.10 $\div$ 16 = 0.006c.

approximately. In this manner the value of p may be figured out very closely, using any other fireman factor.

In order to facilitate the handling of the Mono premium system three log sheets are worked out, as shown in Figs. 6, 7 and 8. The observations to be made—namely, time, the A points during this time, the B points as well as the premium points $A - B$ during this time—

Every fourteen days these observation data are added together and the average determined. These results are finally entered in the fortnight protocol, Fig. 7, which contains the fireman factors as well as the bonus paid during the past year divided into 14-day periods. This log is preserved by the superintendent or other responsible party.

Mono-sheet Fig. 6 **Boiler** 5

Day	Hours	Fireman: R			Hours	Fireman: S.			Hours	Fireman: B.			Hours	Fireman:
	T	A +	B −	Premium-Point A−B	T	A +	B −	Premium-Point A−B	T	A +	B −	Premium-Point A−B	T	A + B − Premium-Point A−B
30/11.	5	44	8	36	10	102	13	89						
1/12	6	68	17	51	10	130	20	110	8	90	15	75		
2/12	6													
3/12	6													
4/12	6													
5/12	6													
6/12														

Fig. 7 **MONO-FORTNIGHT-PROTOCOL**

Fireman: B Mill:

Number: 1

TIME	Boiler 1					Boiler 2					Boiler 3				
	T	E	T×E	ΣT×E / ΣT	P $	T	E	T×E	ΣT×E / ΣT	P $	T	E	T×E	ΣT×E / ΣT	P $
July 7 to July 15	124	69.4	8605-6	69.4	1.01	—	—	—	—	—	132	66.1	8725.2	66.1	0.93
											62.8	6405.6	64.7	0.64	
											600	2880.0	63.9	0.20	
											68.7	6045.6	65.0	0.70	
											70.1	11987.1	66.6	1.54	
											73.5	12274.5	68.2	1.68	
											—		—		

Fig. 8 **MONO-DAY-PROTOCOL**

DATE

Boiler	Fireman R.		Fireman S.		Fireman B		Fireman	
	Fireman-factor	PREMIUM $	Fireman-factor	PREMIUM $	Fireman-factor	PREMIUM $	Fireman-factor	PREMIUM $
1	40.6	—	65.6	0.04	52.8	0.10		
2	63.7	0.05	77.9	0.10	80.2	0.18		
3	39.1	—	50.5	—	36.2	—		
4	64.5	0.05	89.1	0.10	90.9	0.17		
5	61.7	0.04	67.2	0.05	58.7	0.04		
Total		0.14		0.29		0.49		

M. 398. 1. 14. 10.

Fireman	Hours T	Premium-factor E	Premium $
R	101	85.3	2.43
S.	113	81.7	2.43
B	87	72.2	1.43
		Total	6.29

$$\text{Fireman-factor} = E = \frac{A - B + 10 \times 1}{32 \times T} \times 100\%$$

Premium pr Premium-Point = p = $0.002

Premium: $p \times (A - B)$ Cents

Premium is calculated between 10 % and 12 % CO_2

Notes:

M. 396. 1. 14. 5.

FIGS. 6 TO 8. LOG SHEETS FOR PREMIUM-SYSTEM RECORDS

are entered upon the log, Fig. 6. An extract is made into the Mono Day Protocol, Fig. 8, which, in order to raise the interest of the firemen, is daily posted in the boiler room. Thus the firemen can watch their efficiency as well as the premiums due them for work delivered on the previous day.

As regards the distribution of the premiums, this must be left to suit conditions in each individual plant. If at all possible, the premium system should be laid out for each individual fireman; that is, each fireman should fire a number of boilers during his shift. In this manner a friendly rivalry will soon develop.

Steam Engineer's License Examination—VIII

By H. F. Gauss

SYNOPSIS—A practical method of laying out Corliss valve gears without the use of empirical formulas or tables of laps and leads. The four-valve engine and the relative advantages of high vs. low speed.

Before leaving the Corliss engine several additional points should be brought out. Thus far the engine has been considered from a purely operating standpoint. For a thorough and comprehensive knowledge of the entire mechanism some idea of the elementary principles of

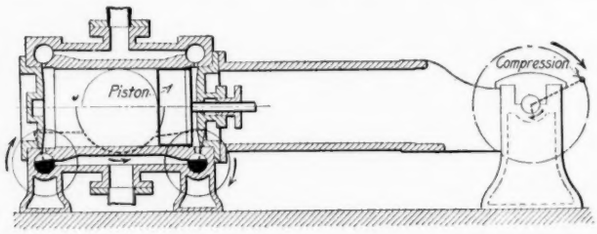


FIG. 1. ENGINE AT POINT OF COMPRESSION

its design and layout should be had. In a simple treatise[1] on this subject, Sanford A. Moss suggests a practical method for laying out a Corliss valve gear without the aid of empirical rules and tables of laps and leads. Very profitable time can be spent in the study of this book.

A fact that should be clearly understood is illustrated in Figs. 1 and 2. The former shows the engine at the point of compression and the latter shows the engine at the point of release. Notice the crank positions and the corresponding eccentric positions at compression and release respectively. In passing from its position at compression to its position at release, the eccentric describes equal arcs on either side of its lower central position. Since the angle between the crank and the eccentric is 90 deg. plus the angle of advance, and remains constant, it follows that when the crank is midway between its

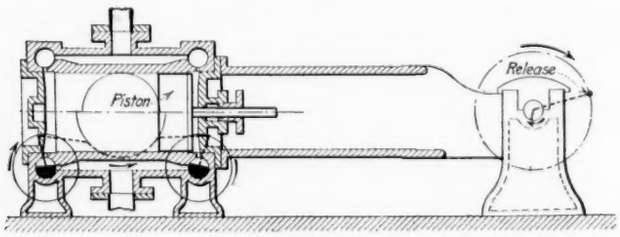


FIG. 2. ENGINE AT POINT OF RELEASE

positions at compression and release, the eccentric must be in its lower central position. Hence, with the crank in the position mentioned, the angle between it and the horizontal must be the angle of advance. It follows then that the points at which it is desired to have release and compression occur determine the angle of advance.

Thus, suppose it is desired to have compression occur at 94 per cent. of the stroke and release at 98 per cent., the angle of advance may be determined as follows: On the horizontal, Fig. 3, lay off a distance AB representing the stroke to scale. AC = 94 per cent. of AB; AD = 98 per cent. of AB. Project C and D to C' and D' respectively; bisect arc $C'D'$ at E. Then EOB is the angle of advance.

The following empirical rules may be used as a guide for determining proper engine proportions:

1. The width of the steam ports is given by the formula,

$$W = \frac{nld}{7.63VK}$$

W = Port width in inches;
n = Revolutions per minute;
l = Length of stroke in inches;
d = Diameter of cylinder in inches;
V = Velocity of steam in feet per minute (V = 7000 to 8000 ft. per min. for the steam ports);
K = Ratio of the port length to the cylinder diameter (K = practically unity in most cases).

2. The amount the valves travel past the ports in opening is called overtravel and may be assumed to be about one-fourth of the port width.

3. The steam lead should be about one-sixteenth of the port width.

4. The amount by which the valve overlaps the port edge when in the closed position is called the seal and should be one thirty-second of the port length.

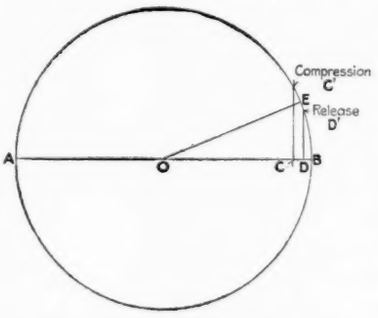


FIG. 3. DETERMINING THE ANGLE OF ADVANCE

5. In general the diameter of the valve-seat bore should be made at least three times the port width and is frequently made one-fourth of the diameter of the cylinder bore. The valve-seat bores for both steam and exhaust valves are usually the same.

6. The length of the arm of the steam bell-crank to which the steam link is attached should be at least 1¼ times the valve-seat bore.

7. The wristplate pins are generally set on a radius at least equal to the radius of the cylinder bore; however, the dimension may be varied either way.

Fig. 4 is a complete layout of a Corliss valve-gear mechanism showing the proportions of the various parts, and constructed according to the method described by Mr. Moss in the book previously referred to.

The application of the Corliss engine is limited by the speed required. Owing to the inertia of the valve mechanism, speeds in excess of 150 r.p.m. are not obtainable with the ordinary Corliss engine, and a valve gear must be resorted to which is moved positively throughout the complete stroke; that is, a nonreleasing gear must be used.

For moderately high speeds, say from 175 to 200 r.p.m., the four-valve engine has been developed. There

[1] "The Layout of Corliss Valve Gears," by Sanford A. Moss.

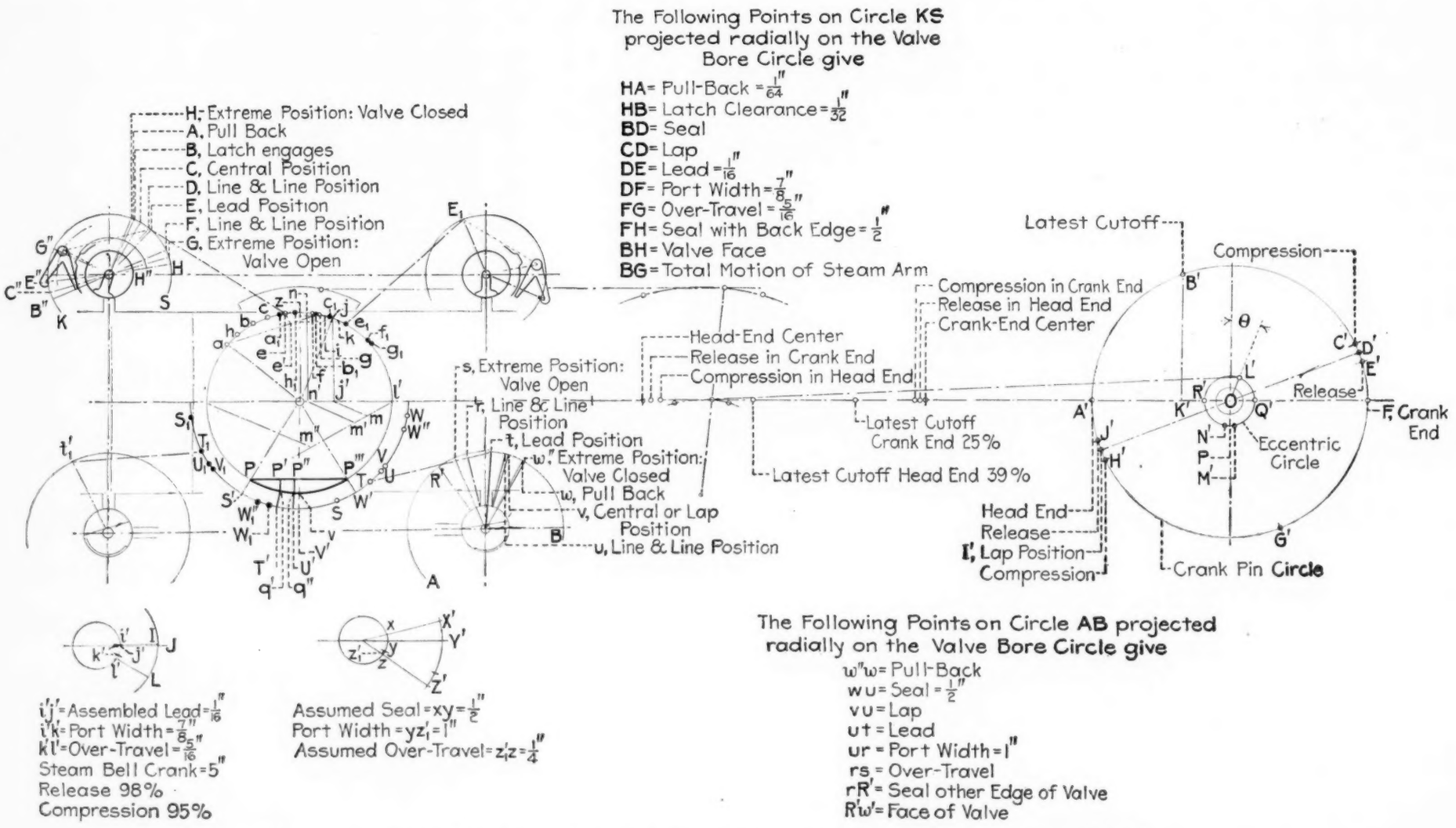


FIG. 4. LAYOUT OF A SINGLE ECCENTRIC CORLISS VALVE GEAR FOR A 15½ x 24-IN. CYLINDER ENGINE

are a number of four-valve engines on the market that are equipped with circular oscillating valves driven by means of an eccentric through a system of bell-cranks and levers so arranged that a quick opening and closing is secured with a minimum idle travel of the valve. The exhaust valve is generally driven by means of a wristplate or its equivalent.

The valves themselves are similar to the ordinary Corliss valve; in fact, the principal difference between this valve gear and the Corliss valve gear is the method of securing cutoff and the system of governing. The steam valves are always under the positive control of the eccentric, and the eccentric position is generally controlled by a shaft governor, to be considered later.

Fig. 5 is the cylinder end of a four-valve engine having a valve-gear mechanism that is simple and positive. Fig. 6 is the part that is located in a gear box bolted to the side of the engine frame, shown in detail. *A* is the exhaust-wristplate pivot, driven by a separate eccentric, that controls the exhaust valves. The advantages gained by the use of the wristplate are:

1. Excessive overtravel can be reduced; that is, it is possible to so proportion the links and arms that the motion transmitted to the valve after once open or closed is small.

2. The valves are allowed to rest during the period in which the unbalanced pressure is greatest. Thus, during the first part of the stroke, when full steam pressure is on the back of the exhaust valve, the valve is practically at rest.

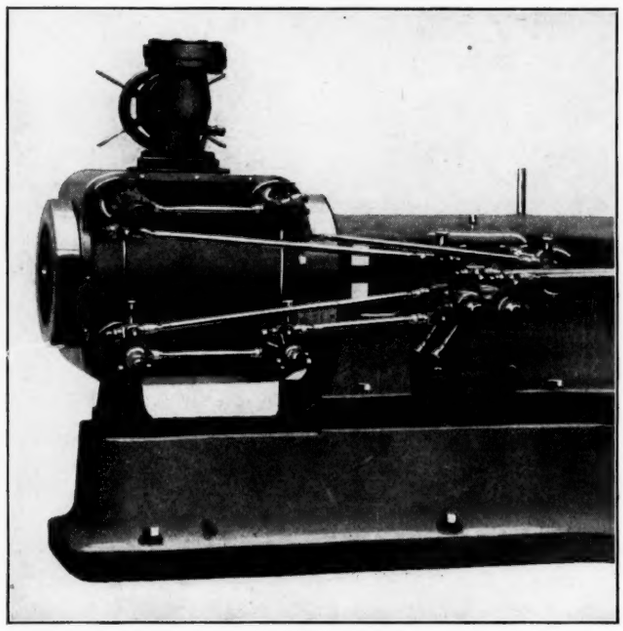


FIG. 5. FOUR-VALVE NONRELEASING ENGINE CYLINDER

3. By means of the wristplate the valve can be opened and closed quickly.

Returning now to Fig. 6, *B* is the shaft to which the arm driven by the steam eccentric is keyed. Fastened to the other end of this shaft is a bell crank, or V-shaped casting, shown phantom in the figure. The arms of this bell crank are double, and at their outer ends are the pins *CC* forming a bearing in the clevis of each double arm. The upper arms *DD* are keyed to the shafts *E*, each of which in turn carries a double or clevised arm *F* on the opposite end. The inside arms are connected by short links *GG* respectively, and the mechanism is so designed that a quick opening and closing is secured without the usual releasing gear used on the Corliss engine. The governing is done by means of a shaft governor controlling the position of the eccentric. From the outside arms *DD* connecting-rods extend to arms on the steam-valve stems.

A prime requisite for successful high-speed engines is liberal bearing area in all details, especially in the valve gear, and adequate means of lubrication. There must be a minimum of lost motion in all joints, and the parts must be heavy enough to resist vibration. It is easier to overload a high-speed engine than one operating at low speed, and a high-speed engine is more easily injured by excessive overloading. The rapid reversals of stress, the inertia of rapidly moving parts, the attendant difficulties of proper lubrication and the making of adjustments while the engine is running are all responsible for the foregoing facts. A properly designed high-speed engine run at its proper load is oftentimes more desirable than a slow-speed engine. One great advantage is the reduced floor space required.

No attempt will be made to give detailed rules for setting the valves of this type of engine. However, by bearing in mind the principles outlined in the preceding article for setting the releasing Corliss valve gear, the setting of any circular oscillating valve should not be difficult. Rocker arms and wristplates must rotate through equal angles to either side of their central positions. With wristplates and rocker arms in mid-position, the valves should cover the ports by their proper lap. With the engine on either dead-center, one steam valve should be open by the proper lead to steam, and the exhaust valve should be open by the proper lead to exhaust. This last adjustment is secured by means of the eccentric. For any particular engine catalogs and descriptive literature can usually be obtained from the manufacturer for the asking, together with detailed information and instructions for setting the valves.

In order to combine high rotative speeds with large power, it is necessary to make the piston area large as compared with the length of the stroke. In general the clearance volume of an engine is directly proportional to the area of the piston. The clearance volume is all the space between the piston face, the cylinder head and the inner faces of the valves when the engine is on dead-center. In short-stroke high-speed engines the clearance volume is a greater percentage of the piston displacement than in slow-speed long-stroke engines. Loss from this cause is materially reduced by compounding, which is therefore desirable for short-stroke engines.

The high-speed engine has its most important application in the driving of direct-connected generators. It can be made smaller for a given power, gives a more uniform turning effort and has a higher mean temperature in its cylinder walls than slow-speed long-stroke engines.

Single-acting engines have been run successfully at speeds as high as 500 r.p.m. They have the special advantage that they can be run at high speed without the tendency to knock owing to reversals of stress. This is due to the fact that the moving parts are maintained constantly in a condition of thrust; that is, the piston pushes on the crank on the down stroke, and the crank must in turn raise the piston on the up stroke.

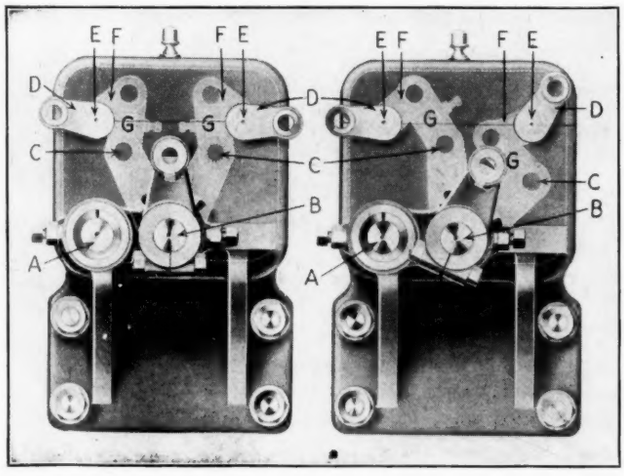


FIG. 6. GEAR CASE OF QUICK-ACTING FOUR-VALVE ENGINE

Editorials

War a Test of Power

We are at war! It has been long in coming. We have been patient and long-suffering, but it was not to be avoided. President Wilson in a message that spoke the thought of every true American has stated our case, and Congress has responded to his call.

Until now the rumblings of the titanic struggle have been subdued by distance and confused by divided sympathy. Some American homes have been invaded, some American hearts bereaved by Teutonic ruthlessness, but to most of us it has been a newspaper story of horrors beyond realization. These horrors are now our own; for how long and to what an extent depends upon the promptness, the thoroughness and whole-heartedness with which we marshal all our forces to combat them. Every piping pacifist, every skulking slacker, everyone whose sympathy or hate or devotion to another cause leads him to impair the unanimity with which all America should arise against the common peril, gives aid and comfort and encouragement to the enemy and helps to prolong the struggle and add to our share of the grief.

The countries which are engaged in this gigantic death grip are highly organized entities. The military and naval arms are the visible, the spectacular points of contact, but back of them are the vital forces of the nations, the forces which supply the sustenance for those who toil as well as for those who fight: the organizations, financial, industrial, agricultural, which keep the national house in order and back up the fighting lines with steady streams of ammunition and supplies and a sense of a dependable support back home. It is upon our readers that the industrial and transportation arm of this organization is largely dependent. This is a war of industry. The side that can get the most material into shape to be used and into the places where it is most needed will be the victor; and to do this requires power.

Frank Gilbreth, in connection with his efficiency work in Germany, was visited at his hotel by an official of the German government. When they were leaving, the official said, "One moment; your key, please"; and returning to the room that they had just left, he turned out the electric light that Mr. Gilbreth had left burning. The power, the coal, to run that light was a factor in the straightened resources of the empire. We have already begun to feel the stringency. How much can we all do in many little ways to conserve our own resources and apply what we use to the best advantage?

The power plants of America have got to win the war. The guns may throw the shells, but the power plants make both guns and shells and the steel that they are made of and the explosives with which they are filled and the railroads and ships that carry them, and we must have more steel, more rails, more guns, more powder, more shells, more ships. The power plants make or prepare, as well, all the other necessities of life at home as well as at the front; and these muscles of the nation must be guarded against internal treachery, against the ever-present danger of accident or disablement, and made to do their great part worthily and well in the momentous struggle which is before us.

The Boston Symposium

In *Power* of April 3 we announced that the Boston Section of the American Society of Mechanical Engineers was going to have a two-days' meeting to discuss the relative fields and advantages of central-station service, isolated plants and municipal stations.

But it wasn't.

The secretary of the section thought so and invited well-known exponents of the advantages of each to present their views.

But they didn't.

The president of the Edison Electric Illuminating Company of Boston protested vigorously against the intention of the committee to hold such a discussion.

But it hadn't any.

Members of two public-utilities companies who claim the credit of canning such a meeting are overpresumptuous.

There was none to can.

David H. Chapman, who has had some interesting experiences with block plants, was going to present a paper.

But he didn't.

Morris Llewellyn Cooke, who said some rude things about public-utility experts, was going to be there.

But he wasn't.

F. W. Ballard, who designed the largest municipally owned station in America, intended to present a paper.

But he didn't.

It was the hope of many who attended that there would be considerable discussion.

But there wasn't.

The members of the committee who swore that no public-service corporation could dominate and control the meetings of the American Society of Mechanical Engineers ignited prematurely.

No public-service corporation would think of doing such a thing.

And it is real nice that they wouldn't. There was a (probably mistaken) impression prevalent a couple of years ago that a carefully prepared discussion of the Smoke Nuisance, also by the Boston Section, was laid on the table indefinitely out of deference to their remonstrance. It is real heartening to have the assurance of the chairman that the meeting was carried out quite in accordance with the original intention, for there are those who believe that these are engineering questions and that their solution will best come through their frank and open but dignified discussion by engineers upon an engineering basis, and who would be very much concerned by the thought that a great national professional engineering society would abnegate its right to discuss such questions or allow any doubt to be cast upon its ability to discuss them in an impersonal and professional manner.

Reconnecting Induction Motors

Polyphase induction motors form such a large percentage of the total capacity of power drives in use at the present time that an understanding of the type of windings used in these machines and the way in which they may be rearranged to meet different conditions is of paramount importance to the engineer and the electrician. Especially is this true since the combinations of voltages, cycles and phases in use make an almost unlimited number of conditions that these motors may have to work under if moved from one locality to another. Wherever such a change takes place, the electrician or engineer is confronted with the problem of adapting the motor to the changed condition.

Fortunately, the polyphase induction motor, in respect to regrouping the windings to operate under new conditions with practically its original characteristics, is quite flexible. The winding in the average machine can usually be easily rearranged to meet several conditions of voltage and frequency and two- or three-phase, although in some instances the changes are so radical and the results so uneconomical that it is poor engineering to make the change. It is with the purpose in mind of showing what changes can and what cannot be successfully made in the windings of the foregoing type of equipment that the series of articles on reconnecting induction motors is being published. The article in this issue on the subject is of such importance that particular attention is called to it.

The average diagram of an induction-motor winding, even the simplest form, is somewhat complicated, and those who have to do with this type of equipment frequently feel the need of some simple method of laying out winding diagrams, also a reliable and easily applied check as to their correctness. Especially is there a necessity of such a check for star- and delta-connected windings with several pole-phase groups in parallel, or in many of the other complicated groupings that these windings are sometimes arranged in to meet special conditions. Even when the pole-phase groups of each phase are connected in series, which is the simplest arrangement of a three-phase winding, there is always the danger of getting the different phases grouped in a sixty degree instead of in a one hundred and twenty degree relation.

In this issue Mr. Dudley has given a simple and reliable means for checking the correctness of induction-motor winding diagrams. The method is so simple and easily applied as to make it of great importance to all who have to do with alternating-current machinery. We quite agree with the author that this check should be studied and thoroughly mastered, as it is the one check that he has found in fifteen years of practical experience that is always reliable and easily applied. The only exception to this check is in the case of consequent pole machines to be described in the next article, but these are so special and so infrequently met with that they may be practically put out of consideration and the check may be regarded as practically universal.

⁂

Boston Reader: "Symposium—In ancient Greece, a drinking together; a compotation, usually following the banquet proper, with music, singing, and conversation; hence, now, any convivial gathering, esp. one marked by free interchange of ideas in general conversation."

Webster's Dictionary.

Important Boiler Legislation

New Jersey has enacted a law providing for the appointment of a board of boiler rules, the personnel of which shall consist of the Commissioner of Labor, the members of the Steam Engine and Boiler Operators' License Bureau and two citizens to be appointed by the Governor. This board is to formulate rules and regulations for the safe and proper construction and use of steam boilers, and no boiler shall be installed or used in the state unless it conforms to the rules adopted by this board. Such legislation is highly commendable—its scope is state-wide; it has no strings attached; and it leaves the board free to adopt the best there is to be had. Thus given a free hand, it is hoped that the board will embody in substance the A. S. M. E. Code, for the sake of uniformity and as representative of the best thought of the country on this particular subject.

New York is also considering boiler legislation, but instead of being in the lead as becoming the Empire State, it is far behind its neighbor. The inspection of boilers in factories has for some time been a function of the State Industrial Commission of the Department of Labor, wherever the boilers are not inspected by duly authorized insurance companies or by local inspectors, such as in New York City, Buffalo, Syracuse and Yonkers. The new proposal is that the Industrial Commission adopt the A. S. M. E. Code as affecting new installations, and hearings are now being held in the more important cities of the state.

This is good as far as it goes, but it does not go far enough. The primary and, in so far as concerns the state, the only reason for having a boiler code is to protect the public. Then why should not those in office buildings, hotels, apartment houses, department stores, theaters, etc., be protected as well as those in factories? Moreover, why protect a man for eight hours of the twenty-four and leave him without such protection during the remaining sixteen?

The excuse is offered that the appropriation is insufficient to cover state-wide inspection and that the Industrial Commission, even if it had jurisdiction, with the limited facilities at hand would not care to assume responsibility for the whole field. New York of all states can well afford the expense of maintaining an adequate boiler-inspection department. It matters little whether this be a separate body or whether it come under some existing department, so long as its scope is broad enough to cover all boilers in the state, that it have no encumbrances and that it be made up of men eminently fitted for the duties to be performed.

⁂

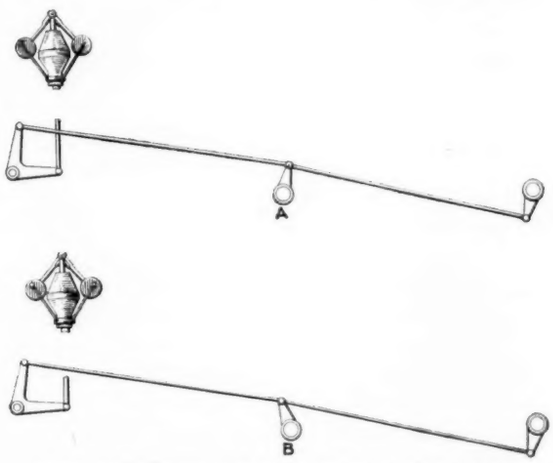
Elsewhere in this issue is shown the disastrous effects of the explosion of a hot-water tank at the works of the Hudson Motor Car Co. All the seams were welded by the oxyacetylene process and the weld at one head appears to have failed through sheer fatigue. Inspection of the weld at the point of failure is said to have revealed indications of poor workmanship. That no one was hurt was because no one was present. Unfortunately, pressure vessels used for this purpose do not come under the otherwise excellent regulations of Detroit. In view of the general advocacy of autogenous welding for pressure vessels, this explosion is a grim reminder that welders and engineers should make progress slowly.

Correspondence

Equalization of Cutoff

The article on "Steam-Engine Troubles" by Mr. Hamkens, page 284, Feb. 27 issue, states that the cutoff on a Corliss engine cannot be equalized except for one load. This is quite true for the general run of valve gears.

Several years ago, while field expert for an engine builder, I had considerable trouble from this cause. The engine was a single-cylinder, and the valve gear was of the double-wristplate type with the eccentrics set so that



TWO POSITIONS OF THE KNOCK-OFF CAMS

the cutoff was controlled by the governor from zero to about three-quarters stroke. This combined with the double-ported valve made a small steam lap essential. The amount called for on the diagram was $\frac{3}{16}$ inch.

The trouble came about in trying to satisfy the superintendent of the plant, who wanted the engine run with no load and the throttle wide open and the cutoff equalized at quarter stroke. With the cutoff equalized for the desired load, the head-end steam valve had such a small movement at no load that the dashpot would not develop sufficient vacuum to return the valve to full lap without closing the pet-cock on the vacuum cylinder; then when the full load was on, the cushion was not sufficient to prevent slamming.

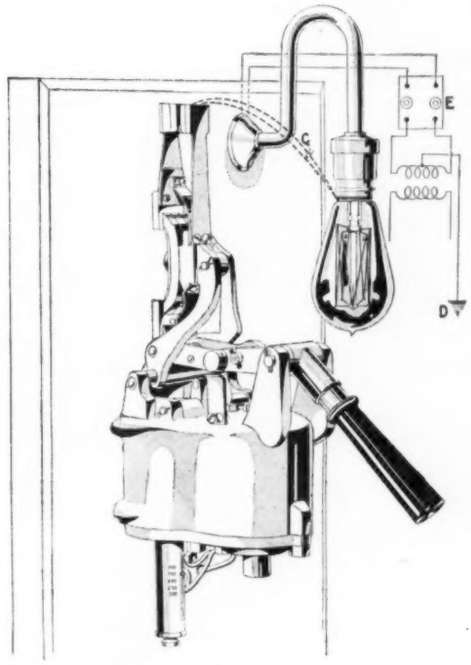
The arrangement of the knock-off cams and governor connections was as shown at *A* (see illustration). As an experiment I moved the knock-off steel on the crank end so that the cam was changed to the position shown at *B*, causing it to move more rapidly than the head-end cam and effecting a partial equalization of cutoff. After this experiment it was an easy matter to convince the general manager of the advantage to be gained by changing the lengths of the cam arms in order to equalize the cutoff. The change was made not only on that engine, but for all the engines built thereafter, the head-end arm being made longer than formerly, the crank-end remaining the same. This change was so simple that a subsequent suggestion to increase the radius of the wristplate pin for the head-end steam-valve rod was not adopted on account of pattern changes, symmetry of valve gear, etc. The latter change would have given a better steam line on the head end, which was considerably lower than the crank end owing to the shorter valve travel for the same point of cutoff, and at the same time equalized the cutoff without changing the knock-off cam.

It does not seem to be advisable to introduce the complication necessary to equalize the cutoff throughout the range of the governor, but it does seem strange that anything so simple as the equalization at lead and the point of cutoff for normal load has not become the standard practice with Corliss-engine builders. There is a decided advantage, especially where there is a wide variation in the load, and the cost is insignificant. E. P. Haines.

Philadelphia, Penn.

A Peculiar Ground

A rather unusual ground occurred in our substation, caused by the arc from a circuit-breaker jumping across to the base of a lamp on the switchboard. Although the breaker had opened numerous times before, it had never given any trouble. It was installed at the top of the board



CIRCUIT-BREAKER AND LAMP

in the positive side of a railway circuit with the lamp about 6 in. away, as shown in the figure. When the trouble occurred, there was a short-circuit on the feeder protected by the breaker. The distance between the breaker and the lamp being small, the current arced to the base of the lamp, when the former tripped out as indicated by the dotted lines *C*. The lamp base, to which one terminal of the filament was soldered, protruded about

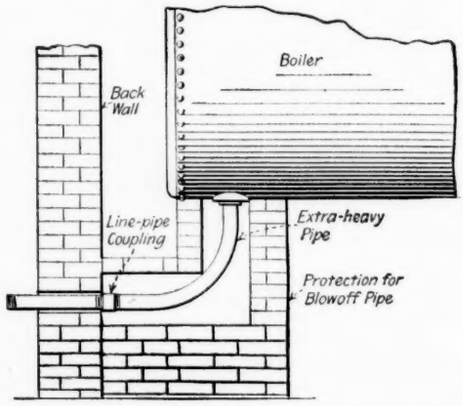
one-eighth of an inch out of the socket, as it does in most cases. The lighting-circuit transformer secondary was grounded at *D*. Since direct current was flowing through the breaker, it will be seen that there was a dead short-circuit during the time the circuit was opening. There was a set of 10-amp. 110-volt fuses on the lighting circuit at *E*, and the voltage of the breaker being 550, the current arced across the former fusing the plugs into the sockets. The current followed the leading-in wire into the lamp and then jumped across to the other leading-in wire, fusing the glass between the two.

The whole occurrence was of short duration, probably only during the time between which the breaker started to open and came to rest. After the base of the lamp and socket was taped up, no further trouble occurred.

Fairfield, Maine. LEON L. POLLARD.

No Elbow on Blowoff Pipe

The trouble with a broken blowoff described by John F. Curren in the issue of Jan. 30, page 161, could have been averted by the use of a long bend made of extra-



BLOWOFF PIPE PROTECTED BY A BAFFLE WALL

heavy pipe, instead of an elbow protected with a brick baffle wall, as shown in the illustration. We have used this kind of arrangement on four boilers for 12 years with no replacement and no trouble. J. O. BENEFIEL.

Anderson, Ind.

The Metric System

I am sorry to see that the editor of *Power* "straddles the fence" on the metric system. "We should like to see the movement in the direction of a single universal standard progress as fast as possible, with due regard to the equation of the possible present hardship with the growing expense and difficulty which will be occasioned by delay."

As the representative of the great body of steam users in this country, and of manufacturers of appliances for using, weighing and measuring and transporting water, steam and gas, *Power* ought to have some facts, statistics and definite opinions in regard to the actual progress, if any, that is being made by the metric system, instead of a vague desire "to see the movement in the direction of a single standard progress as fast as possible, with due regard," etc. It might as well say that it would like to see the movement in the direction of a single standard language (English, Spanish or Volapuk) progress with due regard, etc.

One of the strongest objections, from a practical standpoint, to the metric system is stated in *Power's* editorial. It is: "Every day adds to the tables and formulas, the drawings and patterns, the literature and finished parts which will have to be discarded or altered if either one of the other systems wins." Considering the hundreds of millions of dollars that have been invested in these things by the English-speaking race, which does probably three-quarters of all the measuring that is done in the world, will *Power* consider who is going to pay the cost of discarding or altering these things, and what benefit, if any, will be gained by discarding them? How much will our export trade gain by our adopting the metric system? Are there any facts in existence to show that any of the advertisers in *Power* have lost any trade because their boilers, engines, pipes, valves, etc., were not built on the metric system? If the metric system has made any progress in the English-speaking nations in forty years except in the expenditure of tons of paper and barrels of ink in its propaganda, where is the evidence of it? WILLIAM KENT.

Montclair, N. J.

Defends Full-Stroke Valve Gear

In connection with Fig. 150 of the article on page 314 of your Mar. 6 issue, "Steam-Engine Troubles—Releasing Gears," certain statements are made to which we take exception. Certain alleged shortcomings of this valve gear are mentioned, followed by the statement: "For American practice, where simplicity, reliability, durability and ease of repairs are of paramount importance, this valve gear can hardly be recommended." It is strange that such a statement should be allowed to slip by when there are a great many Corliss engines running today with this type of valve gear, which is made by the Nordberg Manufacturing Co., of Milwaukee, and is known as the full-stroke valve gear.

At the Utah Copper Co., Salt Lake City, Utah, there are three 32 and 70 x 48-in. engines direct connected to 1600-kw. generators at 100 r.p.m.—the largest engines in the world running at this speed—which are fitted with this valve gear. At the Wisconsin state capitol there are three 14 and 28 x 36-in. engines, driving 250-kw. direct-current generators at 120 r.p.m.

At the power house of the Miami Copper Co., Miami, Ariz., there are three 19, 37, 40 and 40 x 48-in. four-cylinder triple-expansion engines direct connected to 1200-kv.-a. alternators, and two 22 and 37 x 42-in. air compressors driven by two 14, 28, 30 and 30 x 42-in. four-cylinder triple-expansion engines, all equipped with this valve gear. Many other installations can be cited, including two tandem compound engines in the power house of the Nordberg Manufacturing Co., at Milwaukee, which have been carrying continuous heavy overloads during these days of great shop activity.

But perhaps one application of this valve gear that more than anything else indicates its reliability, durability and simplicity and would seem to contradict most strongly the statements in the article is its use on the Nordberg air hoisting engines, many of which have been installed at the mines of the Anaconda Copper Co., Butte, Mont., and in other parts of this country and Canada.

These air hoists work on a most interesting cycle, described by B. V. Nordberg in a paper before the American Institute of Mining Engineers, August, 1913. By the employment of this gear,[1] the cylinders are operated first as air engines with full stroke and no cutoff, then with cutoff and expansion of the air, and also compression on the return stroke, followed by a change that results in the working of the cylinders as air compressors with variable capacity, which is gradually increased as it is desired to bring the hoist to a stop at the end of the trip.

H. W. Dow, Sales Manager,
Milwaukee, Wis. Nordberg Manufacturing Co.

Oil or Compound Feeder

On page 161 in the issue of Jan. 30 Mr. Tarn shows an oil or compound feeder connected on the pitot-tube principle, but I fail to see wherein it differs from those of the past 25 years.

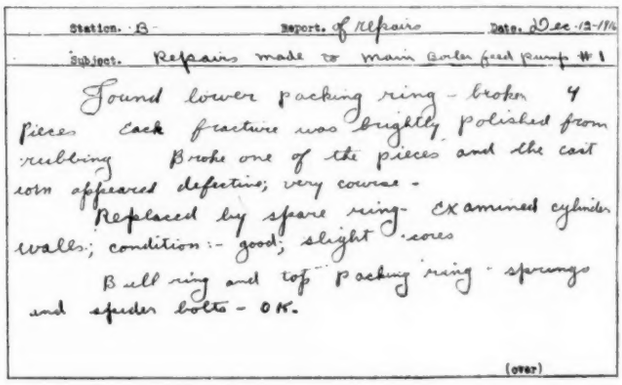
What he calls a "pitot tube" is the same as the inlet and outlet tubes on some of the old-style lubricators. Different combinations have been used in assembling the steam-inlet and oil-outlet pipes on different makes, but the principle is the same in all. Such a lubricator will feed fast or slow, according to the condensation, just as in the ordinary lubricators, and if the valves are left open, will continue to feed just the same. Single- or double-connection lubricators give about equal satisfaction, but sometimes one is more convenient to use than the other. My preference is a good oil pump where the ordinary lubricator is unsuitable.

JOHN JAMES.

Portsmouth, Ont., Canada.

Diagnosing Trouble

An interesting editorial appeared in *Power* recently under the heading, "Diagnosing Trouble," and having adopted a satisfactory system that not only serves to

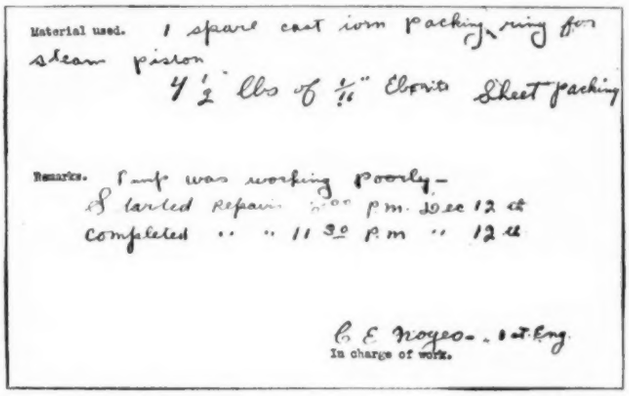

Station. B Report. of Repairs Date. Dec 12-17
Subject. Repairs made to main boiler feed pump #1
Found lower packing ring - broken 4 pieces each fracture was brightly polished from rubbing Broke one of the pieces and the cast iron appeared defective; very coarse -
Replaced by spare ring. Examined cylinder walls; condition :- good; slight scores
Pull ring and top packing ring - springs and spider bolts - O.K.
(over)

REPAIR REPORT CARD—FACE SIDE

diagnose many troubles, but is useful in many other ways, it may interest other readers.

"Repair Index" is probably a good name to give to the system. There are two index files, one in the plant engine room and the other in the manager's office. All machinery, piping, valves, boiler appliances and tools are indexed. Full data as to serial number, the make, dimensions and general description, along with date of installation, are recorded on the first card, under the item heading. The file report cards are 5x8 in. and are printed and used in the form shown in the illustrations.

When a breakdown occurs and repairs are made, a report card is filled out, giving all data, and this card is sent to the office, where a copy is made for the file there, and the original card is returned to the plant file for


Material used. 1 spare cast iron packing ring for steam piston
4½ lbs of 1/16" Elorit Sheet packing
Remarks. Pump was working poorly -
Started Repair 3:00 p.m. Dec 12 th
Completed " " 11 30 p.m " 12 th
C. E. Rogers - Asst. Eng.
In charge of work.

REVERSE SIDE OF REPORT CARD

ready reference. This gives a continuous history of each individual piece of machinery under its own heading in the card-file index.

Sketches are sometimes made and attached to the report card. Reports of inspections of boilers, safety appliances, and other important data are also filed, ruled blank cards being used to enter any special data. The daily log sheet is kept as usual, and when a shutdown of any unit occurs, the time is noted in the log with a remark as to cause, and the full data are recorded in the report-card files.

H. C. WILLIAMS.

Concord, N. H.

Cracks in Boiler Settings

Under "Inquiries of General Interest," page 29, July 4, 1916, issue, I have come across the inquiry, "How can settings of horizontal return-tubular boilers be constructed to prevent cracks in the brickwork?" The reply is to be commended, and although it is stated that only "serious danger from failure of the setting by crumbling or cracking can usually be averted by providing suitable binder bars for clamping together the masonry," the lay reader should not assume that cracks can be prevented in that manner. I believe I can say, after a lifetime trying to do this thing, that bolts and binders cannot and do not entirely prevent a boiler setting from cracking. Binders or buckstays of suitable size, when properly placed, are useful and I apply them in a particular way, but we should get at the cause of cracks and then administer the medicine. I doubt if there is a return-tubular boiler setting anywhere that is free from cracks if the boiler is supported by lugs resting on the side walls or is suspended from a system of gallows-frames and hangers in the old customary way. In some of these settings the cracks are bad, some worse and some very bad, and yet these settings are used day after day, with no particular attention paid to their condition, in the belief that cracks must exist.

If your correspondent is sufficiently interested to examine three 84-in. x 20-ft. boilers set by the late Prof. George Farwell, at the Eastwood Wire Works in Belleville, N. J., he will find their large expanse of brickwork (probably 15

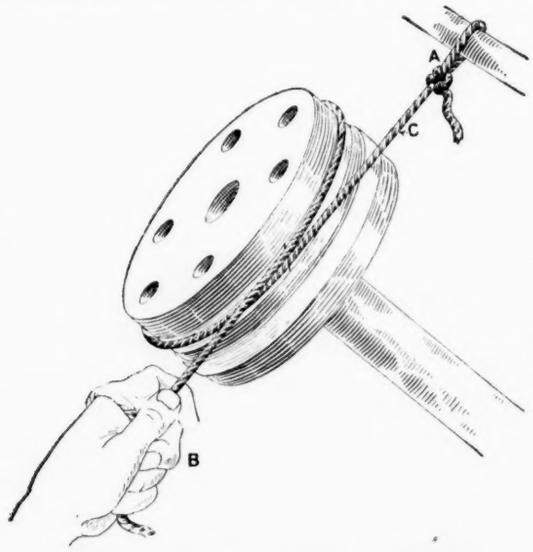
[1]For description of this gear and operation of the engine, see "Power," Nov. 7, 1916, p. 640.

ft. high by 27 ft. long) without even a hair crack anywhere; and if my memory serves me, there are no buckstays or binder bolts unless possibly a single binder forward and one aft. These boilers were set seven years ago and have run continuously ever since. Professor Farwell went into the question minutely to get at the seat of the trouble of cracking walls, and this is the result. I mention this to show that one cannot, by first arbitrarily fixing on some one of the old methods of supporting or suspending the shell of a boiler, work out a plan that will prevent the walls from cracking by relying on any particular scheme of buckstays, tie-rods, patent arch blocks or expanding bridge-walls. O. C. EWAN.

New York City.

Clamp for Piston Rings

A good idea is shown by E. L. Davis in his article, "Clamp for Piston Rings," on page 262 of the Feb. 20



PISTON RING COMPRESSED BY A CORD

issue, but unless he has a large number of rings, a simpler method can be used. I have had occasion to replace piston rings many times and have done it with very little difficulty by passing a strong cord around the ring, one end being secured to anything that is at right angles to the cylinder head. Referring to the illustration, *C* is a strong cord passed around the ring and fastened at *A*. When an assistant pulls at *B*, the ring is easily sprung to a less diameter than the piston and can enter the cylinder without trouble. I have entered rings in small cylinders alone with this method. F. P. KINDER.

Saxonville, Mass.

Counterweight Loose in Armature

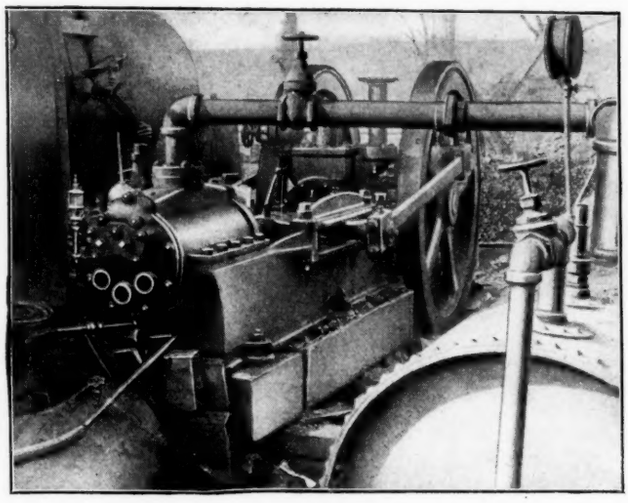
Some weeks ago a peculiar noise in one of our 200-r.p.m. direct-connected engine-generator units was noticeable in starting up and shutting down, but could not be heard when the engine was up to speed. It seemed as though some part of the governor was loose or out of place, and the sound occurred at the same part of the revolution but not at every stroke. After trying for several days to find the cause of the knock, we decided that there must be something loose in the armature. Getting two men to assist, one to turn the engine over slowly and one to watch on each side of the generator, we found a point at which something seemed to drop. Then, with a light, after fishing for some time inside of the armature with a ¼-in. rod about 2 ft. long with a hook at one end, I found that there was a piece of loose metal inside of the armature spider. The machine was turned until the loose object was on top, and it was found to be a chunk of lead weighing about 6 lb. As it was too large to get through the opening in the spider, it required considerable work to get it out.

The lead had evidently been used as a counterweight in balancing the armature and was poured into a dovetailed recess, but in some manner had worked loose. No attempt has been made to replace the lead as the unit seems to run as well as ever. If the speed was high, as in a turbine, it would probably be necessary to replace the weight to prevent excessive vibration. This is the first time I ever heard of a balancing weight working loose, and I can see no good reason why it should have done so.

Hyattsville, Md. J. C. HAWKINS.

An 1887 Air Compressor Still in Service

Contractors, particularly small ones, often employ machinery that has outlived what might be counted a reasonable period of usefulness, but there are few air compressors older than the one shown in the illustration. The shop number (264) identifies it as built in 1887 at the New York City shops of the Ingersoll Rock Drill Company. The air and steam cylinders are 10 in. diameter



AN OLD-TIME AIR COMPRESSOR STILL AT WORK

and 18 in. stroke. One striking feature is the absence of a water jacket. The air cylinder is cooled by a spray of water pumped into the cylinder with each stroke. This early arrangement is less effective than even the insufficient water-jacketing of the machines which immediately followed and is not to be compared with those of the present day. This compressor was built for the Hackensack Water Co. for aërating water and was in continuous use for ten years; then, after a period of idleness, it passed into the hands of contractors and was employed on various jobs. It is now operating rock drills on a foundation excavation, giving continuous service with scant attention.

New York City. H. L. HICKS.

Inquiries of General Interest

Alternating-Current Arc Welding—Has alternating current ever been successfully employed for arc welding? V. B.

A number of attempts have been made to use alternating current for arc welding, but as far as we know none has proved satisfactory, although various methods of resistance welding have been successful.

Preventing Sulphuric Acid from Attacking Wood—Can you suggest a reliable treatment for wood used in storage-battery work against the action of sulphuric acid? E. M. C.

The best and most general treatment for any woodwork around storage batteries is to apply several coats of good asphaltum paint. Before applying the paint, care should be taken to neutralize any acid that may be on the wood with a solution of baking soda and water, after which the surface should be allowed to thoroughly dry.

Detection of Broken Stay-Bolts—How is breakage of a screwed and riveted water-leg stay-bolt detected? H. J.

With hollow stay-bolts, or stay-bolts that have their outside ends drilled with a hole that extends to the fracture, the breakage is announced by escape of water. Breakage of a solid stay-bolt is generally, though not always, accompanied by leakage around the end, and the leakage is increased by a hammer test, but certainty of breakage between the stayed sheet only can be determined by drilling.

Clockwise Motion for Opening Hydrants—What is the advantage of having fire hydrants and water-works valves open by turning to the right; that is, contrary to the usual direction for opening small globe valves? C. E. L.

From becoming jammed when closed or from corroding while standing closed, hydrants and water-works valves usually require more force for opening than for closing them. The main advantage of clockwise motion to effect opening of a valve or hydrant is that in applying a wrench in that manner the average person can exert greater twisting effort when holding the wrench on the end of the valve spindle with the left hand and pulling the wrench with the right hand.

Prevention of Belts Running Off Pulleys—In operating belt-driven pumps we have tried several different kinds of belt dressings, but are having much trouble with belts running off the pulleys. Should not this be remedied by the use of a good belt dressing? E. M.

A good belt dressing will increase the adhesiveness and pliability of a belt and by permitting use of the belt with less tension may cause it to track better, but a dressing cannot be depended upon to prevent the belt from running off the pulleys when the pulleys are out of line or are unprovided with crowning faces.

Why Priming Causes Pump To Pick Up Easier—Why can a water pump with a suction lift be started easier if the pump chamber is primed or filled with water? P. F.

On account of the large clearance spaces of the cylinders of a water pump, it operates very imperfectly as an air pump in displacing and reducing the pressure of air that is ahead of water in the suction pipe. By priming the pump the clearance spaces are filled, and as there is less volume of air to be expanded to a lower pressure, fewer strokes of the piston are required for reducing the air pressure in the suction pipe sufficiently for atmospheric pressure to overcome the pressure in the suction pipe and raise the suction water to the pump chamber.

Heat from Steam Turbine Exhaust vs. Reducing Valve—We have a pressure-reducing valve that reduces steam from 150 to 2 lb. pressure, and we use the low-pressure steam for heating. Can we put a steam turbine with 2 lb. back pressure in place of the reducing valve and get the same heat from the exhaust as when using live steam reduced to 2 lb. pressure? G. S.

There would not be the same number of B.t.u. available per pound of the initial steam after it has been used in the turbine as after only passing through the reducing valve. In passing through the reducing valve, each pound of the initial steam has a part of its heat converted into kinetic energy or the energy of motion that is reconverted into heat when the steam is brought to rest. But under ordinary conditions this loss is small and the steam, after being reduced in pressure, contains practically the same number of B.t.u. per pound as when in its original condition and is in a superheated condition; that is, each pound contains more heat than the number of B.t.u. contained per pound of dry saturated steam of the same pressure. In passing through the turbine, the initial steam is deprived of the heat that is lost by radiation and the heat required for conversion into work that is developed, and the higher the efficiency of the turbine the greater the number of B.t.u. per pound of initial steam converted into work. The abstraction of heat reduces the steam at exhaust to the condition of wet steam or steam containing less heat per pound than the number of B.t.u. contained per pound of dry saturated steam of the same pressure.

Equivalent Evaporation and Boiler Horsepower—What would be the equivalent evaporation from and at 212 deg. F., and the boiler horsepower, for an evaporation of 30,000 lb. of water per hour from a feed-water temperature of 212 deg. F. to steam at a gage pressure of 105 lb. per sq. in. and actual temperature of 465 deg. F.? C. O. K.

The pressure 105 lb. gage = 105 + 14.7, or about 120 lb. per sq.in. absolute. Dry saturated steam at 120 lb. absolute has a temperature of 341.3 deg. F., and if the steam at that pressure has a temperature of 465 deg. F., it would be superheated 465 — 341.3 = 123.7 deg. F. According to Marks and Davis steam tables, a pound of steam at 120 lb. absolute, when superheated 120 deg. F., contains 1254.2 B.t.u. above 32 deg. F., and when superheated 130 deg. F. contains 1259.3 B.t.u., and by interpolation, for superheating 123.7 deg. F. a pound of the steam would contain

$$1254.2 + \frac{(1259.3 - 1254.2) \times (123.7 - 120)}{130 - 120} = 1256.1 \text{ B.t.u.}$$

With feed water at a temperature of 212 deg. F., each pound of water converted into steam would be equivalent to evaporation of $\frac{1256.1 - (212 - 32)}{970.4} = 1.1089$ lb. of water from and at 212 deg. F., and evaporation of 30,000 lb. of water per hour under the actual conditions would be equivalent to evaporation of 30,000 × 1.1089 = 33,267 lb. of water from and at 212 deg. F., or 33,267 ÷ 34.5 = 964.26 boiler horsepower.

Test of Saving by Use of Trap—What method of testing would show the financial loss from the use of "cracked" valves for draining condensation from steam coils, steam kettles and other steam-heated apparatus in place of traps, when the drainage in each case is discharged as waste to the sewer or to the atmosphere? H. H. L.

Observe the amount of opening and the pressure on the inlet and outlet sides of a valve through which steam is being supplied only to a coil or other fixture that is drained by a "cracked" valve to be tested, and also observe the pressure of steam in the fixture. Then ascertain the weight of steam that passes through the supply valve, by disconnecting its discharge side from the fixture and discharging to a tank or barrel containing a known quantity of condensing water, having the original pressure on the inlet side of the supply valve and obtain the same pressure on the discharge side of the supply valve by throttling a valve placed in the pipe leading to the condensing water. The increase in weight of the condensing water in a given time will give the weight of steam that was supplied to the fixture in the same time, and from that the quantity supplied per hour can be determined. In the same manner test the equivalent discharge through the supply valve when the condensate is drawn off by the trap and when there is the same pressure of steam in the coil as when it was drained with the "cracked" valve. The difference will be the greater weight of water that must be evaporated by the boiler for doing the work in one case than in the other. The financial loss will be represented by the cost of evaporating that different weight of water when supplying the fixture with steam.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Further Report of Meeting, Boston Sections, A. S. M. E. and A. I. E. E.

Wednesday and Thursday, Apr. 4 and 5, the Boston Sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers held largely attended meetings at which various power-plant subjects were discussed. Wednesday evening, at the Engineers' Club, Arthur L. Williston, principal, Wentworth Institute, presided. The papers read at this meeting were as follows: "Developments in Fuel Oil and Coal," by Frederick Ewing, mechanical engineer with the Mexican Petroleum Co., New York City; "Up-to-Date Stoker Practice," by J. Sanford Riley, of the Sanford Riley Stoker Co., Ltd., Worcester, Mass.; "High Pressures and Temperatures in Modern Stations," by I. E. Moultrup, of the Edison Electric Illuminating Co., Boston; "Some New Investigations on Combustion in Boiler Furnaces," by Lionel S. Marks, professor of mechanical engineering, Harvard College, Cambridge, Mass.; "High-Temperature Installation of Boiler Settings," by P. A. Boeck, New York City. This meeting was briefly reported in the Apr. 10 issue, and some of the papers read at this meeting will appear in later issues of "Power."

The Thursday afternoon session, it was expected, would be one of the most interesting despite the fact that the meeting was called for the untimely hour of 4 p.m. The assembly room of the institute was crowded with those who had expected to hear an engineering discussion of the relative merits of service from municipal power plants, central stations and independent or isolated plants. The papers were, according to the program: "Principles of Power Plant Management," by Walter N. Polakov, consulting engineer, New York City; "Interesting Isolated Plants," by A. R. Meek, Eastern manager of the Ridgway Dynamo and Engine Co., Boston, Mass.; the same subject, by David A. Chapman, efficiency engineer, of Boston; "Engineering Features and Results at the Holyoke Municipal Plant," by John J. Kirkpatrick, manager of the Gas and Electric Department, Holyoke, Mass.; "Coöperation Between Isolated Plants and Central Stations," by Percival R. Moses, consulting engineer, New York City. Mr. Polakov had at the request of the committee changed the title of his paper from "Principal Factors in the Selection of Sources of Power," while neither Mr. Chapman nor Mr. Moses appeared. William G. Starkweather was called upon to read a paper to replace that of Mr. Chapman.

NO TIME FOR DISCUSSION

A dinner followed the afternoon session, beginning at 6 p.m., which gave but two hours for these five papers and discussions of them. The meeting did not start until 4:10, and although Prof. Frederick R. Hutton, honorary secretary of the American Society of Mechanical Engineers, who was chairman of the Thursday afternoon meeting as well as of the Thursday evening meeting, conducted the meeting in an unusually commendable manner, there was of course no time for discussion of the papers.

Some days previous to the meetings it was generally understood that Morris L. Cook, of Philadelphia, and Mr. Ballard, of Cleveland, both well-known exponents of municipally owned gas and electric plants, were to present papers at the Thursday sessions, but neither of these men appeared.

There were rumors of a change in the program from what had been the original intention or what had been understood as the original intention of the committee. That most of the speakers opened their remarks with the statement that the short time given them for preparation made impossible the presentation of formal papers and that their discussion would be extempore seemed to lend credence to such rumors.

A much-enjoyed dinner was served at the institute at 6 p.m., after the closing of the afternoon session. Chairman Weed of the Boston Chamber of Commerce made a brief address in which he gave figures and other matter of a statistical nature to show the magnitude of the war and what it means as an engineering problem. Dr. Hollis, president of the American Society of Mechanical Engineers, also made an address in which he outlined what the different mechanical, electrical and civil engineering societies were doing in assisting the Government in the carrying out of its military and naval program.

The evening session opened immediately after the dinner, with Prof. Frederick R. Hutton in the chair. John A. Stevens, consulting engineer, Lowell, Mass., who was to have read a paper on "Purchased Power," gave a brief address on what he considered the limitations of the society in its recognition and discussion of engineering subjects. R. A. Langworthy, of Boston, made an extempore talk on engineering features of combined heat and power distribution, the address being devoted chiefly to district heating and to the variation in electric load and heating load and their relationship one to the other. When Mr. Langworthy had finished his remarks, Professor Hutton announced that thirty minutes would be given to the discussion of all the papers read at the meetings up to that time. The entire discussion consisted of an inquiry about the price of fuel oil, a request that Mr. Loewenstein enlarge upon turbines for cotton mills, and a question about fittings for high steam pressures. In the absence of Richard A. Rice, engineer, Turbine Department, General Electric Co., Lynn, Mass., who was to read a paper on "The Development of Steam Turbines." Prof. L. C. Loewenstein, of the General Electric Co., made some interesting remarks relative to turbine development in recent years and especially on higher pressure and superheat and their influence upon steam-turbine practice of the future. The meeting closed with a paper by Charles H. Bromley, associate editor of "Power," dealing chiefly with features of development in the design and operation of condensers and the maintenance of high vacuum in steam-turbine practice, as found in the large modern power stations.

The papers of Mr. Kirkpatrick, of Holyoke, and one read by William A. Starkweather, secretary of the Boston meetings committee, appear here.

RESULTS IN ISOLATED PLANT FOR FACTORY

This power plant and factory are owned by a real-estate company, and the factory is rented to tenants for various purposes, chiefly for the manufacture of shoes. The factory is equipped for steam heat and electric power and light. The owners supply the heat and power required, and the tenants pay extra for the light.

In 1909 the factory consisted of two 8-story brick buildings, parallel to each other and 50 ft. apart. Between them, at one end, was a power house 50 x 72 ft. One of the buildings was 60 x 300 ft., the other was 50 x 250 ft., and together they had a floor area of 244,000 sq.ft. In the power house there were three horizontal return-tubular boilers, 72 in. diameter by 19 ft. 6 in. long, for supplying heat, while the current for power and light was purchased from a central station. The cost of operation for the year was as follows:

Current bought for power, 572,900 kw.-hr. at 1¾c.	$10,025.75
Current bought for light, 30,300 kw.-hr. at 9c.	2,727.00
Fuel	3,718.76
Water	171.33
Wages	1,100.00
Repairs and supplies, estimated	150.00
Total cost to owners and tenants	$17,892.84

This total cost was equivalent to the following rates:

To tenant for light	9c. per kw.-hr.
To owners for power	1.75c. per kw.-hr.
To owners for heat	2.2c. per kw.-hr.

The last rate does not include the interest and depreciation charges due to the boiler-room equipment; but these are not known and need not be considered at present.

During 1910 and 1911 the smaller factory building was increased in length to 400 ft., giving a total floor area of 304,000 sq.ft., and an engine and generator were installed in the power house to supply the current required for power and light.

The generating unit consisted of a horizontal cross-compound engine direct-connected to a 400-kw. alternating-current generator, and a surface condenser of sufficient capacity to give a vacuum of 26 in. under full load. The piping was so arranged that the exhaust steam from the low-pressure cylinder could be delivered to the heating system in accordance with the requirements of that system. The remaining exhaust steam was delivered to the condenser. A varying back pressure against the engine resulted, and a cylinder ratio was adopted that gave the best efficiency under average conditions. This installation cost about $26,000 made up as follows:

Engine, delivered and erected	$9,240.00
Generator and switchboard, delivered and erected	6,949.00
Condenser, f.o.b. factory	1,655.00
Wiring, delivered and erected	1,202.00
Piping, delivered and erected	1,548.00
Sundries, estimated	5,406.00
Total	$26,000.00

The cost of operation during the year 1912 was as follows:

Fuel	$8,464.38
Water	534.76
Wages	2,500.00
Repairs and supplies, estimated	600.00
Interest at 6 per cent	1,550.00
Depreciation at 5 per cent	1,300.00
Total cost to owners and tenants	$14,959.14
Charged to tenants for light, 41,370 kw.-hr. at 8c	3,309.60
Remaining cost to owners	$11,649.54
Chargeable to heating, 304,000 sq.ft. at 2.2c	6,688.00
Chargeable to power	$4,961.54

During the year 864,460 kw.-hr. were generated at a cost to owners of 0.574c. per kw.-hr. instead of the 1.75c. previously paid to the central station.

The figures given show a net saving of over $10,000 a year, which is 39 per cent. on the investment, over and above interest and depreciation charges. Of course such results can be obtained only by a careful and intelligent study of the conditions and a selection of apparatus of suitable type and capacity.

ENGINEERING RESULTS AT THE HOLYOKE MUNICIPAL ELECTRIC PLANT[2]

The City of Holyoke, Mass., has just closed the fourteenth year of operating its gas and electric plants. When the agitation for municipal control of these utilities started, Holyoke had a population of about 41,000; now she has a population of about 63,000.

The first vote upon municipal ownership for the City of Holyoke was taken by the Board of Aldermen on Dec. 15, 1896. That vote was unanimous. On Jan. 5, 1897, the Board of Aldermen again voted unanimously in favor of a municipal plant. The question was then submitted to the people. On Dec. 14, 1897, the people voted for municipal ownership.

The Holyoke Water Power Co., which owned both the gas and electric plants, then offered to sell them to the city at a price of $1,000,000. The city, believing that $500,000 was more than the plants were worth, rejected the company's offer, and the court appointed a commission to decide the value of both the gas and electric plants, as the company had elected to sell both.

It took Holyoke six years from the date that the Board of Aldermen first voted in favor of municipal ownership, to acquire the plants. The first vote was on Dec. 15, 1896, and the plants were turned over to the city on Dec. 15, 1902.

Holyoke paid $706,543 for the plants, which amount included $55,606 as bonus for the right to take and use water power. The award also fixed the rental of the water power at $1500 per mill power per annum—a rental that will cost Holyoke about $24,000 per year until the end of time—interest on $600,000 at 4 per cent. forever.

Because of the comparisons which a contract presented but rejected enables us to make, Holyoke is the only city that I know of that can answer positively the question, "Does municipal lighting pay?" To that question the City of Holyoke must answer "Yes." We know what we would have paid under the contract, and we know what we do pay under municipal ownership.

Had that contract been ratified, the price of electricity in Holyoke would have been 16.2c. per kw.-hr., and had the consumers used the quantity that they did use at the price at which the city sold it, the consumers would have paid to the Holyoke Water Power Co. $1,431,333.45 more than they actually paid to the City of Holyoke in the past twelve years under municipal ownership. Had that contract been ratified and the city used the same amount of electricity in lighting its streets, the city would have paid to the Holyoke Water Power Co. $301,326.39 more than it actually did pay to the Gas and Electric Department during the past twelve years of municipal ownership.

There were no concessions offered under that contract on the price of gas, so it is fair to assume that had the contract been ratified, the price of gas would have remained the same during the term of the contract as it was when the city was asked to ratify it. If the consumers had used the same amount and paid the price that they formerly paid to the Holyoke Water Power Co., they would have paid $474,159.68 more than they did pay to the City of Holyoke, so that the total savings to the city and consumers in the three items mentioned is $2,206,819.62.

Both plants have since been enlarged and extended; their total value today is nearly $2,000,000. The bonds outstanding against the plant are $270,000 in excess of the original issue, so that besides the saving to the city and consumers, as previously mentioned, there is $880,000 of the city's money invested in the plants which has been paid out of the receipts of the department. That $880,000 represents an asset that the city would not have were it not for the municipal ownership of its gas and electric plants.

Our rate of 6c. per kw.-hr. for electricity consumed for commercial and domestic purposes, is, as far as I know, the lowest rate of any in Massachusetts. Are we not justified in saying that municipal ownership in the City of Holyoke does pay?

We are often asked, "Do you pay taxes upon your municipal plant, and if so, how do you do it?" We furnish to the city all the electricity it uses either for street lights or for its public buildings, whether for light or power, at actual cost. Electricity is billed to the city at 2c. per kilowatt-hour.

It is conceded that the prices paid by the City of Holyoke for its street lights are the lowest in Massachusetts. If Holyoke had paid to the department during the last 14 years the lowest prices that any city or town pays for metered electricity in buildings and for its street lights, the city would have paid to the department $397,027 more than it actually did pay to the Gas and Electric Department.

If the law permitted the department to pay taxes and the department did pay taxes upon its construction account, instead of upon a valuation placed by its assessors, at the regular rate of taxation, then the department would have paid into the city in 14 years, $265,961.63. Subtracting this amount from what the city would have paid for its street lighting and lighting its buildings, if charged the lowest rate of any place in the state, we find that the department would have a surplus of $131,065.44 in that account. Therefore we say that we have not only paid taxes to the city in an indirect way, but we have paid $131,000 more than our share of the taxes.

There is a general impression that a large part of the electricity generated at the Holyoke plant comes from water power, and it is often stated that Holyoke has a successful municipal plant because it is largely hydro-electric. That is not so. Holyoke has a hydraulic plant capable of generating about 600 kw., while the steam plant's capacity is 10,250 kilowatt.

The water power is what is locally termed a nonpermanent power, generally known as surplus power. It is available on an average of about nine months of the year and is most unreliable during the nine months. Because of its unreliability, we consider it of little, if any, value to the plant. Many times the water is available only a part of the day and on short notice.

You will probably be surprised to hear that the water power increases rather than decreases the operating expenses at the plant.

During the last 14 years the energy developed by water power has been 24.76 per cent. of the total amount generated.

The following table shows the growth of the department since the city acquired the plants:

	1903	1916
Gas sent out, cu.ft	99,634,400	245,705,885
Gas meters set	3,937	13,569
Miles of main pipe laid	32.35	63.86
Electricity sent out, kw. (estimated for 1903)	1,286,890	18,216,000
Number of electric customers	273	6,011
Number of electric meters set	44	7,513
Number of transformers set	8	327
Miles of wire in street	72	316
Miles of wire underground	.....	24.7
Poles in streets	1,137	2,853
Capacity of station, hp	500	14,666
Luminous arc lamps	.....	144
Type "C" 400-cp. lamps	.....	354
Incandescent street lights	.....	504
Arc street lights	263	.....
Price of arc street lights	$100	.....
Price of luminous arc lamps and type "C" lamps	.....	$75 and $45
Net price of gas per thousand cu.ft	$1.35	.90
Net price of electricity per kw. (estimated average for 1903)	.18	.06
	Dec. 15, 1902	Nov. 30, 1916
Cost of plants	$815,458	$2,100,677
Book value of plants	.....	$1,963,519
Amount added to plants from loans in 14 years	.....	866,000
Amount added to plants from earnings in 14 years	.....	419,219
Bonds paid out of earnings	.....	512,869

[2]By John J. Kirkpatrick.

At a Meeting of the Editorial Conference, held in New York City on Apr. 3, the editors of the trade and technical press of New York assembled transmitted the following resolution by telegram to President Wilson: "That the editors of the New York Business Publishers' Association, Inc., representing class journals of America, at this time of national crisis, are glad to pledge to the President of the United States their loyal support in his action for national defense. They will exert the influence of their journals in every possible way to promote unity of patriotic sentiment in the nation and effective action by every possible agency to aid the Government's military and naval forces."

Compressor Valves—A Review*

By F. L. Fairbanks†

SYNOPSIS—Discusses the faults and merits of various types of valves for gas compressors, with particular reference to ammonia compressors.

In most commercial compressors, especially of 100 tons capacity and over, using the older types of valves, the speed of the unit is limited by the valve action, and this limited speed is generally well under that at which the connected

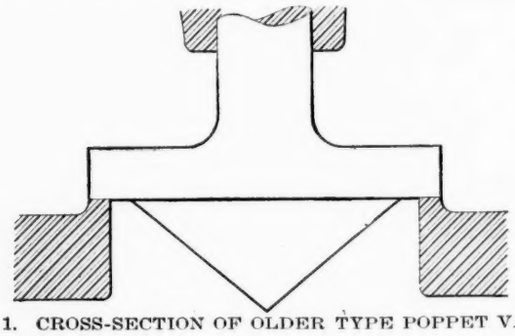


FIG. 1. CROSS-SECTION OF OLDER TYPE POPPET VALVE

steam engine will show its best efficiency. Consequently, any improvement in the compressor valves which allows of an increased speed will result not only in a lower steam consumption per unit of gas pumped, but also in an increased capacity nearly proportional to the increased speed.

With this in mind it will be readily understood why there has been a persistent endeavor in the last two years to increase the speed of compressors by designing lighter valves which reduce the inertia and increase the valve area, which automatically decreases the lift of the valve. It is in these two directions only that success in the direction of increased speeds seems to be attainable, increased spring pressure being only a palliative and not a remedy under normal conditions.

Practically all the investigators and experimenters in this recent work seem to have drifted naturally toward the so-called plate valve, most of the types of which are of German origin with American improvements. It is to point out the

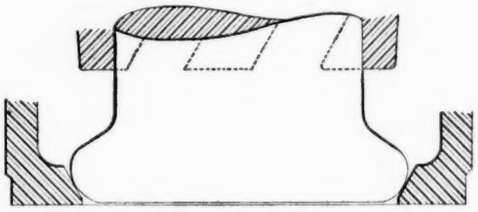


FIG. 2. POPPET VALVE OF LARGE DIAMETER

merits, as well as the defects, of some of these valves that this article is written.

The expressions here given, while more or less true of all gas compressors, are intended to apply particularly to refrigerating machines, and especially to ammonia compressors.

Piston design, in so far as it concerns the packing rings, or method of making the piston gas-tight, is much the same in most commercial compressors, in that this is accomplished by a series of cast-iron snap rings the joint of none of which is gas-tight. A single ring gas-tight would be a decided step in advance of the five open-joint rings which are now used in some compressor pistons.

The cylinder design of some compressors is open to considerable improvement in the passages leading to the valve ports, especially on the suction, or intake, side.

The discharge-valve cages and ports are given even less attention than the suction, when as a matter of fact the average temperature can be lowered appreciably by the proper design, location and water-jacketing of these valves, ports and passages.

*Abstract of an article in "Refrigerating World."

†Chief engineer, Quincy Market Cold Storage and Warehouse Co., Boston, Mass.

Taking up a description of the various types of valves, I will not undertake to describe in detail those of the older types, most of which are well known, and which because of the fact that they are now more or less obsolete may be assumed to have been defective in service to an extent which rendered them at least less desirable than the later types.

Among them may be mentioned the multiported rotary disk, multiported rotary cylinder, balanced piston and semirotary (better known as the Corliss), all of which are of the mechanically actuated, or voluntary types of valves.

Later, a combination of semirotary and poppet valve was brought out, which, while very successful in air-compressor practice, has not been successful in ammonia compression. This type is illustrated by what is known as the cincinnati gear and has been used almost exclusively upon air and natural-gas compressors.

All the involuntary types mentioned, while quiet in action and moderately efficient, have proven deficient in balance, are impossible of effective lubrication, lack of which is accompanied by excessive wear, and are difficult to replace or repair. They are capable of reasonable efficiency only with very moderate speeds. For the reasons mentioned they have been discarded to a great extent in air-compressor practice and have failed almost completely to obtain a foothold in ammonia compressors.

The single-seated poppet valve has survived all the attempts to displace it in refrigerating compressors, and while it now looks as though it would have to fight hard to maintain its place, it is still being used in perhaps 90 per cent. of the compressor construction in the refrigerating field.

The plate valve, however, as represented by two prominent types in particular, is attracting much attention because of

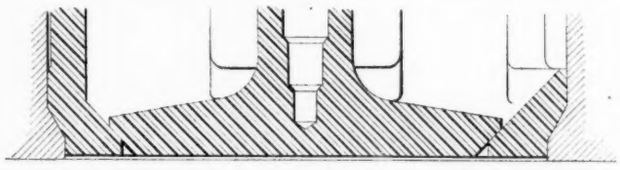


FIG. 3. POPPET VALVE CUT DOWN TO MAKE IT LIGHT

its superior qualities, particularly those of speed, capacity and tightness, and it would not be surprising if, in the near future, it displaced the poppet valve to a large extent.

Of the two prominent types referred to, the first is the thick-plate annular ring with either one, two or three concentric rings, restricted as to lift, which is opened automatically by being lifted from its seat by an excess gas pressure in the cylinder and returned to its seat by some form of spring, either coil, volute or saucer-shaped, which spring, of course, more or less resists its opening.

In some of this type the two or three concentric rings are independent of each other, and in others they are connected by two or more bars of the same material; in some radially and in some the bar is of "S" form, the whole being punched out of a steel plate with a central hole to fit the stud, by which it is guided.

The independent annular ring, either single or multiple, is guided from and to its seat by pins, or a shrouding so placed on the guard or back of the cage as to extend down between the plates in the multiple valve and inside or outside the edge in the single-plate type. A prominent example of the multiple

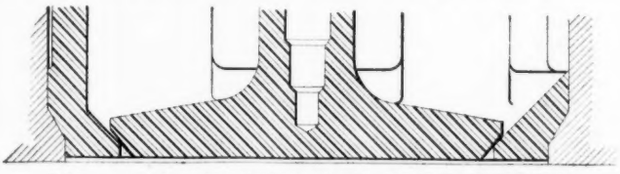


FIG. 4. POPPET VALVE WITH ANGLE CHANGED

independent annular-ring valve is the Simplate, and a like example of the triple-connected ring is known as the Rogler.

The second general type is known as the thin-plate spring type in which a number, usually five, of thin strips of spring steel are laid over as many ports in a seat ring, held in position by a cover, or guard, with milled grooves for preventing extreme lift, and others for the egress of the gas. Each strip of spring steel, known as a "feather," is held in position by the guard, but not rigid at any point, and each

independent of the others. When the valve opens, the ends being prevented from lifting by the shape of the milled guard, it arches up in the center, discharging the gas on either side of the blade; and when the discharge stroke is finished, it seats by its own resiliency, seating with a shearing contact action rather than by impact, the ends of the blade being always in contact with the seat.

This type of valve needs no springs, has practically no inertia factor, is easily capable of speeds of over 600 r.p.m. without distress—which, by the way, is in excess of the safe speed of any of the reciprocating prime movers—and it can be placed in any possible position, vertical, horizontal or otherwise, without interfering with its action, the same valve being used for either suction or discharge, depending only upon the way the cage is inserted into the port; one side up for suction, the other side up for discharge.

Briefly, the principal advantages of the plate valve in general over the poppet valve are:

1. Over-all efficiency, as measured by horsepower expended in compressing and delivering the gas.
2. Durability when the right type is selected for the work to be done.
3. Considerably higher mechanical efficiency of compressor, due to the elimination of friction and unbalance.
4. Astonishingly quiet operation of the valves within their respective successful speed limits, requiring little or no lubrication in themselves.
5. Exceedingly simple valve construction with unusual access to the valves for examination, it being possible to remove and replace the entire cage in five minutes.
6. All valves in the compressor cylinder, both intake and discharge, are identical and interchangeable and with the best design, especially large valve area is attainable through the valve lift, it being possible to have this as great as the area through the seat, this being in sharp contrast to any of the older valves in use.

I would like to call attention to the unbalancing of all voluntary or automatic valves, and particularly of the plate type, which is due to width of seat contact. The cause of a great deal of so-called defective action in the valve itself may be due to this area of seat contact, as related to the total area of the valve.

Fig. 1 shows one of the older types of poppet valves, of small diameter, with the unbalanced area, as shown by the dotted lines, a comparatively large percentage of the total area of the valve. The flat seat as well as the rectangular edge of the valve disk requiring a comparatively sharp deflection of the gases, tending to increase the friction through the area of valve lift, over that of the beveled seat.

Fig. 2 is a well-known type of poppet valve, usually of large diameter, heavy, but the shape of its seat contact is less restricted than that of Fig. 1.

Fig. 3 is a common type of poppet valve which was cut down by the writer to make it as light as possible (weighing

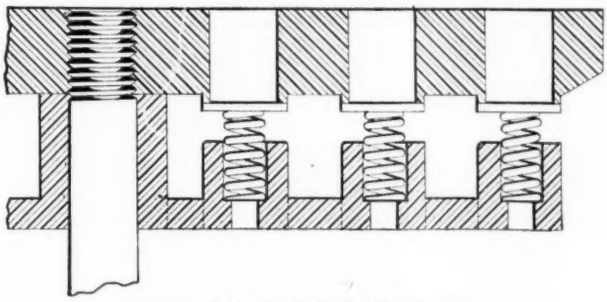


FIG. 5. PLATE TYPE OF VALVE

a little over 2 lb.) and with beveled disk and seat, with a view to deflecting and thereby resisting the flow of gases as little as possible, but it was given, at the time of designing, a fairly large area of seat contact with the idea of permanency and tightness, and after its action was found to be defective and somewhat inefficient, the angle of the valve disk was changed to look like Fig. 4 in which the angle of the disk was different by five degrees from the angle of the seat, allowing the valve to seat on a line of contact having practically no area, which resulted in a tight valve, smooth in its action, no unbalanced area and a somewhat decreased resistance to the flow of gas when open.

Fig. 5 shows the plate type of valve with three concentric annular rings. This is a particularly desirable valve for moderately high speeds, and with this type it is possible to get comparatively large valve area into a small diameter of cylinder port, which makes it attractive for the medium and smaller-sized compressors. It is less subject to destructive flutter at low speeds than the single or double annular ring and remains reasonably tight, but its lift has to be restricted to prevent it from slamming at the higher speeds, as, like the poppet valve, it seats by impact and not by contact.

A peculiar feature of this type of valve is that with the same width of seat the unbalanced area will be a much larger proportion of the total area of the smaller, or inner, plate, or ring, than that of the intermediate ring, which in turn bears a like relation to the outer ring, unless this feature is counteracted in designing.

This feature is taken advantage of, however, to assist in preventing fluttering, and at low speeds only the outer ring is in action, the other two rings coming in operation consecutively at proportionate increases in speed.

It will readily be seen that this characteristic will result in excessive fiber stress in the connecting bar when it is attempted to connect these three rings together.

Fig. 6 shows two views of a cross-section of the thin-plate spring valve, known as the "Laidlaw feather valve": The

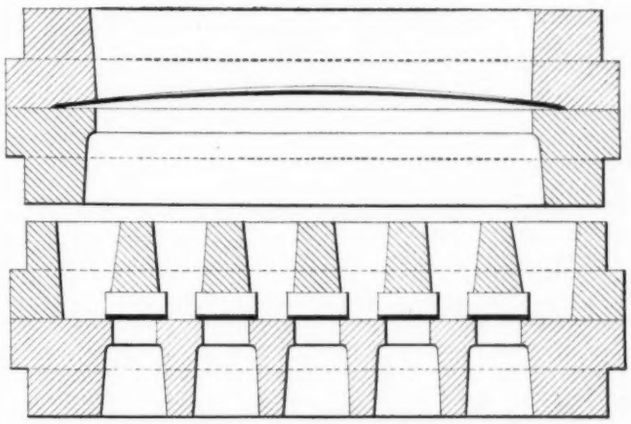


FIG. 6. TWO VIEWS OF LAIDLAW FEATHER VALVE

longitudinal showing the manner in which the feather arches up off its seat in the center, and the transverse section showing the feather seated for its full length, and by its own resiliency.

This is probably the lightest and simplest valve known for the purpose, has practically no inertia factor, its thinness (being about $\frac{1}{32}$ in.) and its length (varying from 4½ to 12 in.) causing it to be tight on its seat under normal conditions, and it lends itself readily to an unusually large port and valve area in the medium and larger sizes of compressor cylinders where it is possible to get the desired port diameter. It is capable of much higher speeds, without distress, than any of the other types of valves mentioned, is durable, cheap, quickly replaced, and because of its shearing action when breaking its contact with its seat, it is possible to nullify almost entirely the unbalancing effect of seat contact by reducing to a minimum the width of seat at the center of the feather.

While lubrication is unnecessary in this valve, it will be found that all types of valves, as a rule, will work better, wear longer and remain tighter if the valve contact with its seat is moistened with lubricant, both plate and feather type getting generally more than they need from the oil used for cylinder lubrication which passes through the valve with the gas, in a more or less atomized state.

Oxyacetylene Welding Discussed

On the evening of Apr. 4 the Chicago Section of the American Society of Mechanical Engineers held its third meeting of the season. The subject was "Oxyacetylene Welding" and the speaker, J. Philip Furbeck. About 125 members and guests were in attendance. The lecture was limited to the practical applications of this kind of welding in manufacturing lines, maintenance of equipment and machinery, reclamation work and the cutting of steel and wrought iron. A large number of lantern slides showed a great variety of work that had been successfully executed at a cost considerably lower than obtained under other methods. Ammonia receivers, high-pressure steam driers, locomotive boilers, light sheet-metal work in automobiles and transformer cases, pipes and tanks of all kinds were some of the objects illustrated. Views of repair jobs were profuse, and a number of slides indicated the wonderful opportunity for the application of oxyacetylene cutting in the field of structural steel and reinforced concrete.

A most interesting discussion followed. At the request of the audience the speaker outlined briefly the process of making acetylene gas. In the free state under pressure the danger

point is 22 lb. per sq.in. It was an easy matter to keep it below 15 lb. in operation, as burners can be obtained requiring only 8 or 9 oz. Railway representatives taking part in the discussion confirmed the advantages proclaimed by the speaker. The views thrown on the screen were everyday jobs with them. In fact, they would not know how to "keep house" without oxyacetylene welding.

It was pointed out that the efficiency of the weld depended largely on the human element. Since some shop operators using this process have been inclined to look more to the net proceeds than the efficiency of the work and incompetent welders have been appointed to classes of work needing the best operator obtainable, the Government inspectors have had to make some restrictions to date regarding conditions under high pressure.

With competent welders the efficiency of the joint should average above 80 per cent. and, with sufficient reinforcement, might easily exceed that of the material itself. Electric spot welding was given brief mention, and it was predicted that the new automatic welding would prove a big factor in the oxyacetylene field.

Hot-Water Tank Explodes at Detroit

The illustrations show the results of a hot-water-tank failure which occurred at the works of the Hudson Motor Car Co., Detroit, at 4:17 a.m. on Mar. 26. The tank was 45-in. diameter by 72 in. long and was suspended from the ceiling of the first floor of a three-story brick building with reinforced-concrete floors. The shell was made from $\frac{3}{16}$-in. steel with heads of $\frac{1}{2}$-in. steel, and all the seams were welded by the oxyacetylene process, but were apparently done in a poor

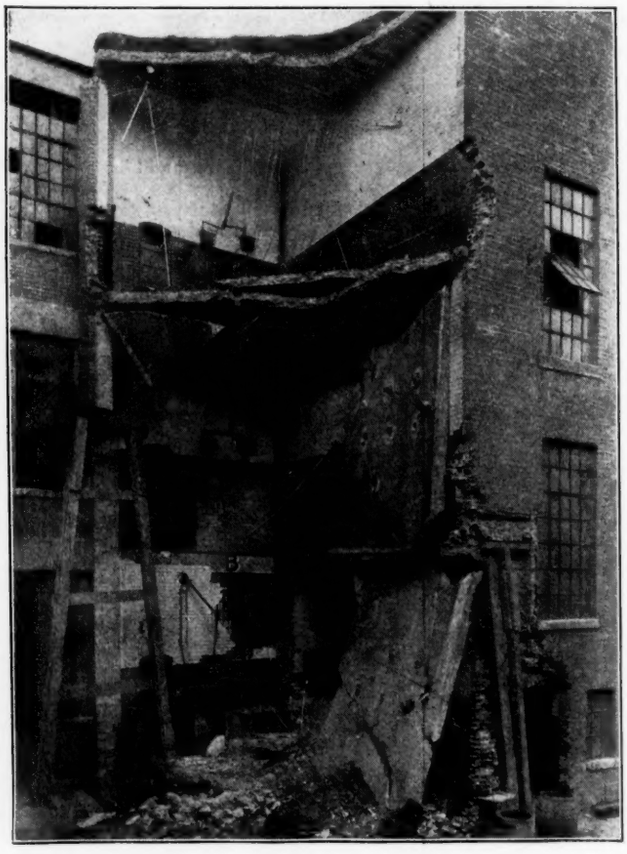


FIG. 1. WRECKED WING OF BUILDING

manner. Vessels used for this purpose do not come under any regulations in Detroit.

In Fig. 2 the head marked A in the illustration seems to have failed from shear fatigue in the welding. The dish of the head could not be ascertained, but was said to be about 3 in. This tank had a closed coil of pipe for the purpose of heating the water contained in it and furnished water to the lavatories. It had a temperature regulator and was supplied directly with water from the mains, the pressure in the mains never exceeding 35 lb. A large number of the bib-cocks in the lavatories were constantly leaking, so that it was rather difficult to believe that any elevation of pressure could occur in this tank, although the supply pipe was fitted with a check valve. It is doubtful if the temperature of the water in the tank greatly exceeded that corresponding to the pressure in the mains, which would be from 260 to 270 deg. The tank was also fitted with a relief valve, which was found to be operative after the accident.

It will be seen from the crumpled end of the tank that it was projected with considerable force against the 12-in. brick

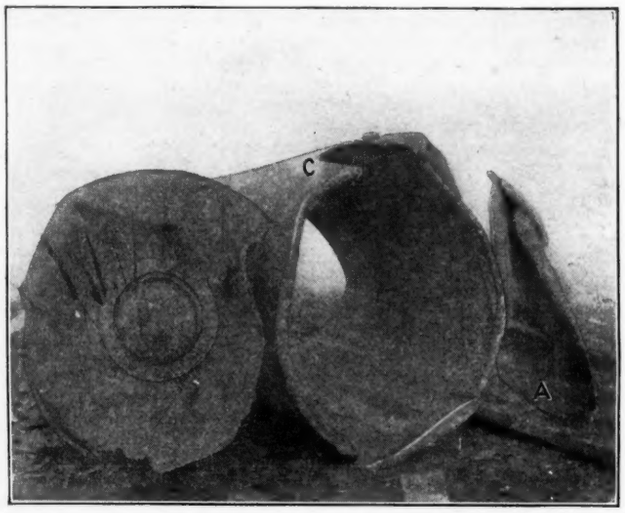


FIG. 2. TANK, SHOWING HEAD THAT FAILED

wall at B, Fig. 1, where it tore a hole through the wall and struck a 60-in. flywheel, wrecking it, and at the same time tearing the tank at C, Fig. 2. After wrecking the wheel there was sufficient energy in the tank to wreck an 8-in. tile wall which surrounded the compressor room. The wrecked wing of the building was in a court or passageway about 30 ft. wide between buildings. At the initial failure some windows directly opposite the tank were pushed in, but after the equalization of pressure, windows higher up were drawn out and broken.

PERSONALS

R. B. Robinson, mechanical engineer, of Allentown, Penn., has joined the forces of the New York Shipbuilding Co. He will assist in the construction of two United States cruisers.

Earl W. Goss has resigned his position with Chester & Fleming, consulting and operating engineers, of Pittsburgh, Penn., to become sales engineer with the Fort Pitt Engineering Co., of the same city.

Le Roy W. Allison, who was associated with the Rice Electric Display Co., of New York, for several years, and has long been a contributor to "Power," resigned his position on Apr. 1 and is now engaged in technical writing and research work at Newark, N. J.

Elmer E. Bassett, who for the last 3½ years has been chief engineer with the Whiting Manufacturing Co., Bridgeport, Conn., has been appointed master mechanic with this company, succeeding M. E. Cutler, who goes with the Hamilton De Foss Co., of Fairfield, Conn., as supervising engineer.

R. J. S. Pigott, who is best remembered as assistant to the late Henry G. Scott, superintendent of motive power, Interborough Rapid Transit Co., New York City, will soon resign as mechanical engineer and power superintendent with the Remington Arms and Ammunition Co., Bridgeport, Conn., to take up the work of research engineer with the Sanford Riley Stoker Co., Ltd., with offices in New York City.

Walter B. Snow and Staff announce the following additions to their organization: Frank C. Thomas, formerly connected with the advertising departments of the Cadillac Motor Car Co., "Hardware Age" and Cleveland (Ohio) manager of the J. Walter Thompson Co.; Clarence C. Jones, formerly sales and advertising manager of the British North American Tobacco Co., Ltd., and later manager of "System's" Advertisers' Service Bureau; Charles W. North, formerly in charge of the art department of the "Iron Age" and "Hardware Age."

ENGINEERING AFFAIRS

The Boiler Makers' Supply Men's Association will convene May 22-27 at Hotel Jefferson, Richmond, Va.

The Philadelphia Section of the A. S. M. E. will give an entertainment for Dr. Ira N. Hollis, on Apr. 24.

The Master Boiler Makers' Association will hold a convention at the Hotel Jefferson, Richmond, Va., May 22-25.

The National Association of Manufacturers will hold a convention at the Waldorf-Astoria Hotel, New York City, May 14-16.

The American Boiler Manufacturers' Association will hold a convention in the William Penn Hotel, Pittsburgh, Penn., June 25-26.

The St. Louis Section of the A. S. M. E. will hold a meeting on Apr. 18. "Refrigeration Problems of a Modern Hotel" will be discussed.

The Providence Section of the A. S. M. E. will hold a meeting on Apr. 23. Discussion will be on "Routing, Principles and Machine Symbols."

The National Association of Cotton Manufacturers will hold its annual meeting in Boston, Apr. 25-26, with headquarters at the Copley-Plaza Hotel.

The Detroit Section of the A. S. M. E. will hold a meeting on Apr. 20. J. W. Lieb will speak on "Leonardo da Vinci, Artist, Philosopher and Engineer."

The Society for Electrical Development, Inc., will hold its annual meeting May 8, at its offices in the United Engineering Societies Building, New York City. Directors for the ensuing year will be elected.

The Combined Associations of Brooklyn N. A. S. E. will visit the offices and laboratories of the Fuel Engineering Co., 106 East 19th St., New York City, on Apr. 26. A lecture on coal analysis will be delivered by one of the laboratory staff. All interested are invited to attend. Secretary, John B. McGowan.

The Society of Automobile Engineers, in accordance with amendments proposed, discussed and adopted at recent meetings, will, after Apr. 19, the date set by the Supreme Court of the State of New York, be known as the Society of Automotive Engineers, Inc. The next council will have 15 instead of 12 members, and on it will be five second vice presidents, representing automobile, aviation, tractor, marine and stationary internal-combustion engineering.

The American Institute of Steam Boiler Inspectors, Boston No. 1, at its meeting on Apr. 2, elected the following officers for the coming year: John H. Gleason, president; Adam Oldfield, vice president; Edward R. Doherty, treasurer; John J. Molloy, secretary. On the executive committee are: Charles D. Noyes, Thomas P. Service, Harry T. Horsman, Harry E. Morton and Edward F. Masterson. The society will hold its eighth annual banquet on Wednesday evening, Apr. 25, at the Copley Square Hotel.

The New Haven Section of the A. S. M. E. will hold a meeting on Apr. 19. In the afternoon Herbert C. Nickerson, chief engineer of the New Haven Water Co., will read a paper on "Water-Works Pumping Engines," followed by a visit to the city pumping stations, before the dinner. In the evening Dr. Ira N. Hollis will speak; illustrated papers will then be given by F. F. Nickel on the "Development of the Centrifugal Pump," and by H. M. Chase on "Pumping Machinery for Industrial Purposes."

MISCELLANEOUS NEWS

Safety Honors Awarded—Arthur Williams, president of the American Museum of Safety, has made public the report for the year 1916, of the Jury of Awards concerning the award of four of the five gold medals which are given annually by the museum for noteworthy achievement in the realm of safety, and which are as follows: The Anthony N. Brady Memorial Medal, awarded to the American electric railway company, which for the year has done most to conserve the safety and health of the public and its own employees, goes to the Connecticut Co. The silver replica is awarded to S. W. Baldwin, in recognition of his campaign. For similar reasons the bronze replica is awarded to W. J. Flickinger, secretary to the president. Honorable mention goes to the Pacific Electric Rys., of Los Angeles, Calif., and the Interstate Public Service Co., of Indianapolis, Ind. The "Scientific American" medal, for the most efficient safety device invented within a certain number of years and exhibited at the museum, is awarded to the Pullman Co. for originating the "Dean" end frame for passenger cars. The Louis Livingston Seaman Medal, for progress and achievement in the promotion of hygiene and the mitigation of occupational diesases, is awarded to the Julius King Optical Co., of New York, in recognition of its scientific investigation of the effect of colored lenses worn by workmen whose eyes are exposed to the blinding glare of metal melting and refining operations, oxyacetylene welding and electric-arc welding. The Travelers' Insurance Co's medal, awarded to the American employer who has achieved the greatest success in protecting lives and limbs of workers, is presented to the Commonwealth Steel Co., of St. Louis, Mo., for its safety system, protective devices, sanitary plant methods and fellowship work among employees. The jury has not yet completed its deliberations relative to the award of the E. H. Harriman Memorial medals.

BUSINESS NOTES

The Jointless Fire Brick Co., of Chicago, announces that it has taken over the business of the Pliable Fire Brick Co. and is now in a position to turn out a more highly developed product.

The B. F. Goodrich Co. announces that L. D. Brown, who was cashier of the First-Second National Bank of Akron, Ohio, is now treasurer of the company at its New York office, succeeding W. A. Means, who has been elected second vice president.

M. R. Carpenter, refrigerating engineer and architect, and H. O. Weldon, structural and refrigerating engineer, have formed a partnership and have opened a new office at 1201-4 Stock Exchange Building, Chicago, still retaining the office of M. R. Carpenter at 62 Pickering Building, Cincinnati, Ohio.

The Chapman Valve Manufacturing Co., of Indian Orchard, Mass., has been awarded a contract amounting to $237,000 for supplying valves to the Obras Sanitarias de la Nacion, a department of the Argentine Government, South America; the valves to be used in constructing water-works plants throughout Argentina.

TRADE CATALOGS

Stevens Under-Feed Stokers. Nelson Blower and Furnace Co., Boston, Mass. Catalog; pp. 16; 6 x 9 in.; illustrated.

Electric Fans. Sprague Electric Works, 527-531 West 34th St., New York. Booklet No. B-3409; pp. 22; 3½ x 6 in.; illustrated.

Single-Phase Motors, Varying Speed. Sprague Electric Works, West 34th St., New York. Bulletin No. 41,514; pp. 12; 8 x 10½ in.; illustrated.

R & D Paracoil Feed Water Heater. Row & Davis, Engineers, Inc., 90 West St., New York. Bulletin No. 52; pp. 4; 8½ x 11 in.; illustrated.

R & D Paracoil Evaporator, Single or Multiple Effect. Row & Davis, Engineers, Inc., 90 West St., New York. Bulletin No. 51; pp. 4; 8½ x 11 in.; illustrated.

Imperial Duplex Dry Vacuum Pumps. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3038; pp. 24; 6 x 9 in.; illustrated. Describes details of construction

Ingersoll-Rogler Dry Vacuum Pumps. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3037; pp. 24; 6 x 9 in.; illustrated. Describes details of construction.

Steam (Vacuum) Pumps, Foot Valves, Quick-Cleaning Strainers. The Emerson Pump and Valve Co., Alexandria, Va. Descriptive catalog; pp. 56; 6 x 9 in.; illustrated.

Taylor Power Dump. American Engineering Co., Philadelphia, Penn. Pamphlet; pp. 16; 6 x 9 in.; illustrated. This pamphlet describes the operation of the dump in connection with the Taylor stoker.

SKF Ball Bearing Hangers and Pillow Blocks. SKF Ball Bearing Co., Hartford, Conn. Bulletin; pp. 48; 6x9 in.; illustrated. This contains tables and curves and engineering data upon mounting, lubrication, testing lubricants, etc.

Desire Manufacturers' Catalogs—Letters have been received from W. H. Friedman, instructor in power-plant design, Department of Education, 345 East 15th St., New York, and Lee J. Whitney, engineer, Coast Artillery Corps, Fort Coswell, N. C., requesting catalogs and bulletins of manufacturers making power-plant and electrical equipment.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Apr. 14, 1917	One Year Ago	Apr. 14, 1917	One Year Ago
Buckwheat	$3.40@4.40	$3.05@3.20	$6.50@6.75	$3.25@3.50
Rice	.....	2.50@2.65	5.50@5.75	2.70@2.95
Boiler	.....	.....	4.25@4.50	.....
Barley	2.65@3.65	2.20@2.35	4.15@4.40	2.35@2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Apr. 14, 1917	One Year Ago	Apr. 14, 1917	One Year Ago
Clearfields	$4.75@5.50	$1.40@1.90	$8.75@9.25	$4.25@5.00
Cambrias and Somersets	5.15@5.75	1.60@2.10	9.00@9.50	4.60@5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $6@6.50, as compared with $2.75@2.85 a year ago; on cars Boston price is $11.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Apr. 14, 1917	One Year Ago	Apr. 14, 1917	One Year Ago
Buckwheat	$3.75@3.80	$2.75	$4.50@4.75	$3.00@3.25
Rice	3.00@3.30	2.20	3.95@4.20	2.15@2.25
Barley	2.50@2.80	1.95	2.95@3.20	2.00@2.10

BITUMINOUS

	South Amboy	Port Reading	Mine Price
Clearfield	$6.25@6.50	$6.25@6.50	$4.25@4.50
South Forks	7.00@7.50	.....	5.50@5.75
Nanty Glo	6.75@6.75	.....	5.00@5.25
Somerset	.....	6.50@6.75	4.25@4.50
Quemahoning	.....	6.75@7.00	4.75@5.00

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Apr. 14, 1917	One Year Ago	Apr. 14, 1917	One Year Ago
Buckwheat	$2.50	$1.55	$3.40	$2.30
Rice	2.00	.90	3.00	1.80
Boiler	1.80	....	2.90	....
Barley	1.50	.55	1.75	1.30

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Apr. 14, 1917	One Year Ago
Slack	$3.25@3.50	$1.10@1.15
Mine-run	3.25@3.50	1.15@1.25
¾-in.	3.25@3.50	1.25@1.40

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current price per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump	$3.00@3.25	$2.50@2.75	$3.25@4.00	$2.75@3.00	$2.50@2.75
Lump	3.00@3.25	3.00@3.25	3.75@4.00	2.50@2.75	3.25@3.50
Egg	3.00@3.25	3.00@3.25	3.75@4.00	2.50@2.75	3.25@3.50
Nut	3.00@3.25	3.00@3.25	3.75@4.00	2.50@2.75	3.25@3.50
No. 1 nut	3.00@3.25	3.00@3.25	.....	.....	.....
No. 2 nut	3.00@3.25	3.00@3.25	.....	.....	.....
No. 3 nut	2.75@3.00	2.75@3.00	.....	.....	.....
No. 1 washed	3.00@3.25	.....	.....	.....	.....
No. 2 washed	3.00@3.25	.....	.....	.....	.....
Mine-run	2.75@3.00	2.75@3.00	4.00@4.25	2.00@2.25	2.50@2.75
Screenings	2.75@3.00	2.75@3.00	.....	2.00@2.25	2.00@2.25

Hocking lump, $3.50@3.75; splint lump, $3.50@4

St. Louis—Prices per net ton f.o.b. mine a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Apr. 14, 1917	One Year Ago	Apr. 14, 1917	One Year Ago	Apr. 14, 1917	One Year Ago
6-in. lump	$1.75@2.00	$1.25@1.50	$1.75	$1.25@1.40	$1.15@1.30	$1.05@1.20
2-in. lump	1.75@1.85	1.20@1.30	1.75	1.10@1.25	.90@1.15	.80@ .90
Steam egg	1.75@1.85	1.20@1.30	1.75	1.10@1.25	.90@1.10	.80@ .90
Mine-run	1.50@1.75	1.05@1.15	1.50	1.05@1.15	.90@1.00	.80@ .90
No. 1 nut	1.75@2.00	1.20@1.50	1.75	1.15@1.30	.95@1.25	.85@ .95
2-in. screen	2.00@2.25	.85@1.00	1.75@2	.80@ .90	.95@1.15	.80@ .90
No. 5 washed	2.00@2.10	.85@1.00	1.75	.80@ .90	.95@1.05	.75@ .90

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Washed		Mine-Run	Washed
Pratt	$3.25@3.50	.....	Carbon Hill	$2.75@3.25	$3.00@3.25
Big Seam	2.75@3.00	$3.00@3.25	Cahaba	3.25@3.50	.....
Black Creek	3.25@3.50	3.50			

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Marion—The Marion Electric Co. will rebuild its electric plant which was recently destroyed by fire. P. Lovelace, Marion, Mgr.

B. C., Enderby—City is considering installing an electric-light plant.

Calif., Salinas—City estimated the cost of a distributing system for lighting the city and also a small substation at $12,868.

Calif., Wasco—City voted bonds to install an electric lighting system.

Ga., Cleveland—W. E. White, Jefferson, is said to have purchased the Henderson Mills and 150 acres of land and will construct an electric-light plant.

Ill., Allendale—E. Greathouse and E. Campbell are reported interested in a company which has been organized to build and operate an electric-light plant. The company is capitalized at $8000.

Kan., Denton—City will install an electric-lighting system and may build a transmission line to Hiawatha to secure energy.

Kan., Palco—City considering installing an electric-light plant.

Maine, Lewiston—The Lewiston, Augusta & Waterville Street Railway Co. plans extending its power facilities this year. Estimated cost, $200,000. M. A. Williams, Portland, Pur. Agt.

Md., Baltimore—The Carnegie Steel Co., Bush and Wicomico St., plans to erect a 42 x 62-ft. power house at Gunpowder and Severn St. Estimated cost, $5000.

Minn., Anoka—The Federal Cartridge Co. is having plans prepared for a power house. P. R. Seidell, 1913 Dupont St., Minneapolis, Pres.

Minn., Faribault—F. W. McKellip, City Engr., is preparing plans for an electric-light plant.

Mo., Aurora—City plans election to vote on $25,000 bonds to install an electric-lighting plant.

Mont., Denton—O'Neill & Saunders, Great Falls, have applied to the city council Denton for franchise to install and operate an electric-light plant in the city.

N. Y., New York—(Borough of Manhattan)—The Interborough Rapid Transit Co. has had plans prepared for a boiler plant, signal tower and storage house at its yards at 239th St. Estimated cost, $70,000. F. Hedley, 165 Broadway, Vice Pres. and Gen. Mgr.

N. C., Kelford—City considering installing an electric-light plant. J. E. Tyler, is reported to be interested.

Ohio, Ashley—The Ashley Electric Light and Power Co., recently organized with $10,000 capital stock, plans to construct and operate an electric-light plant. E. A. Wakeman, Mgr.

Ohio, Dayton—The Lindner Bros. Sanitary Milk Co. plans to purchase the site next to its property at 723 East May St. and plans a power plant. Estimated cost, $15,000.

Ohio, Mansfield—(Official)—Secy. Bd. of Control receiving bids Apr. 24 for 8 electrical-driven reciprocating pumps and 2 electric-driven centrifugal booster pumps and 1 electric-driven air compressor. W. J. Hazletine, City Engr.

Ohio, Mt. Gilead—(Official)—The Hydraulic Press Manufacturing Co. will construct a 42 x 60-ft. steel, concrete and brick power plant and will install a new 300-hp. Corliss engine and a 300-hp. water-tube boiler equipped with an automatic stoker. The company's present power plant will remain intact for use in case of an emergency or as an auxiliary.

Okla., Frederick—City voted $35,000 bonds to purchase the local electric-light plant and improve the same.

Ore., Portland—City plans election June 4 to vote on $1,770,000 bonds to install an electric-light plant including area of watershed 53½ sq.mi.; water available with storage, 108 second ft.; length of flume, 13 mi.; capacity of reservoir, 4,000,000 cu.ft.; length of penstock, 3000 ft.; effective head, 650 ft.; horsepower available, with storage (24 hours per day), 6380; transmission line, 30 mi. Detailed cost of the system is as follows: Diversion, $26,500; flume, $286,000; right of way, $1320, forbay and reservoir, $55,000; penstocks, $82,500; wagon road, $22,000; power house, $49,000; machinery, wiring, etc., $170,500; transmission, $82,500; distribution system, including transformer station, $1,001,000. P. Dater, City Engr.

Penn., Ellwood City—The Pennsylvania Power Co. applied to Public Service Comn. for permission to issue $10,000 bonds to extend and improve its plant. J. W. Disbrow, Gen. Mgr.

Penn., Lansford—The Panther Valley Electric Co. plans to construct a high-tension transmission line in connection with its local substation. W. Drumheller, Mgr.

Penn., Reading—The Reading Transit and Light Co. plans to improve and extend its plant. Estimated cost, $200,000. H. Riegel, Pur. Agt.

S. D., Gettysburg—City considering installing an electric-light and power plant. H. Triplett, Aberdeen, Consult Engr.

S. D., Lesterville—City will hold an election to vote on additional bonds to improve the electric-lighting plant.

Tenn., Centerville—City retained Frank Wilcox, Syndicate Trust Bldg., St. Louis, Mo., to prepare plans for an electric-lighting system.

Tenn., Newport—The Newport Mill Co. plans improving its power plant including a new power house and new equipment.

Tex., Wellington—The Wellington Power and Light Co. will rebuild its plant recently destroyed by fire. Estimated cost, $15,000.

Va., Harrisonburg—The city plans to construct an additional unit to its hydro-electric plant on the Shenandoah River, 14 mi. east of this city.

Wash., Bellingham—The Bd. of Education plans installing an electric-light and power plant in the Whatcom High School.